U. P. COLLEGE OF AGRICULTURE
LIBRARY
Received 6/29/15

The Philippine Agriculturist and Forester

Twenty-five Centavos a Copy
Two Pesos a Year

Foreign Subscription: 1.50 Dollars a Year

Vol. IV. May, 1915 No. 2

IMP. BUR.
22 JAN. 1925
ENTOM.

CONTENTS

	Page
The Cost of Rice Production by Philippine Methods	29
Forest Rangers Graduate	43
Bamboo Planting at the College of Agriculture	43
Some Experiments in Pineapple Planting	45
Influence of Compost Covers on Conservation of Soil Moisture	51
The Coconut	58

ILLUSTRATIONS

Partial View, College Nursery	42
Corner View, College Campus	50

PUBLISHED BY

The Student Body of the College of Agriculture

Los Baños, Philippines

GET THESE BOOKS

You will find them a real help to you

PRACTICAL LESSONS IN TROPICAL AGRICULTURE

By ROB'T L. CLUTE, B. S., B. Pd.

Its aim is to present to the student the fundamental principles of practical agriculture, and to prepare him to make intelligent application of those principles in farm work.

Price, ₱1.80 each. Postage, ₱0.16 extra.

GENERAL AGRICULTURAL CHEMISTRY

By HART AND TOTTINGHAM.

Written in the interest of the young farmer and the student beginning the study of agricultural chemistry. A survey of the general field of chemistry applied to agriculture, with emphasis placed on the applied side. Hypotheses and theories have not been discussed. Gives, in general, only well tested and established principles.

Price, ₱4.50. Postage, ₱0.24 extra.

HANDBOOK OF TROPICAL GARDENING AND PLANTING

By H. F. MACMILLAN.

The aim of the author has been to supply as concisely as possible and in a manner to suit the practical man in the field or garden, the kind of information most generally sought for, not only on horticultural matters, but also on general planting and agricultural subjects.

Price, ₱7.50. Postage, ₱0.64 extra.

ORDER DIRECT FROM

PHILIPPINE EDUCATION CO., Inc.

34 Escolta Manila, P. I.

The Philippine Agriculturist and Forester

Twenty-five Centavos a Copy
Two Pesos a Year

Foreign Subscription: 1.50 Dollars a Year

Vol. IV | May, 1915 | No. 2

The Cost of Production of Rice by Philippine Methods*

By Catalino G. Aurelio

Thesis presented for graduation from the College of Agriculture No. 30.

Introduction

Viewed from the economic standpoint of all classes of people, rice is the most important of all staple Philippine crops. But up to less than a decade ago no effort had been made to study the many problems that attend its culture. During this decade millions of pesos worth of this product has been imported each year. This importation went on before, and it still goes on, in the face of the statement that no country under the sun is better fitted for raising rice than are the Philippines. Something is wrong. Either too little land is devoted to this crop, or not enough rice is produced on the area planted to it.

Of late years studies on rice have been started by the Bureau of Agriculture. The most important of these are on seed selection, with the aim of isolating and making known the most productive types and of propagating them for general distribution. In the College of Agriculture some work of the same kind has been carried out on upland rice; and standardization of commercial rice has recently been attempted. This paper is the report of a study of production and its cost, in native paddy culture. An idea of comparative efficiency here and elsewhere can be obtained from total production, and unit area production of rice in some important rice growing countries for the year 1913. This is taken from E. J. Butler's article on "The Cultivation of Rice in Spain and the Recent International Rice Congress at Valencia," published in the Agricultural Journal of India, Vol. 9, part 4, Oct., 1914. The data for the Philippines are those of the Bureau of Agriculture for the calendar year 1913, reduced from metric to English terms.

Country	*Area under rice in acres*	*Production in tons*	*Yield per acre in lbs.*
Spain	96,000	246,000	5,700
Italy	360,000	534,000	3,300
Egypt	254,000	375,000	3,300
Japan	7,393,000	7,026,000	2,100
United States	827,000	517,000	1,400
India	70,580,000	28,167,000	890
Phil. Islands	2,991,000	723,000	485

This table speaks for itself. It shows that there are 3 million acres planted to rice in this country

* A part of this paper, in preliminary form, was originally published in the "Philippines Free Press," Vol. 9 (1915).

each acre of which produces less than one-tenth as much as the same area in Spain, the country which evidently gets the most rice from her soil. Compared with that of the United States the yield here is barely one-third, and with Japan the yield is less than one-fourth. It is not the extension of the rice area that is needed here, to stop importation; what is needed is the improvement of the cultural methods, to increase the yield from the area already under cultivation. If this be successfully done, the country will not only stop importation, but will be able to write the account on the other side of the ledger. If Philippine farmers obtained as good yields as those of Spain, the people of the Islands could be abundantly supplied from the present rice area, and at the same time assume a foremost place in rice exportation.

Preliminary to possible improvement in paddy culture in this country, it is of importance first to study critically the methods of cultivation as it is carried on today by Filipino farmers. Attention must be given to all details of practical operation to what they are, and how and to what extent they are performed; to the existing attempts to produce better crops, by seed selection, or by fertilization; to the value of the labor, and to other expenses incidental to the planting, such as rental of land, interest on the money expended, and such other matters as may contribute to the cost of production. The first aim in this study must be to determine the actual cost of production, for it is by first knowing what each unit of the final product costs that one may decide whether rice production by native methods is a paying or a losing business.

For this purpose data were collected from several sources. Studies were made in Calamba, Los Baños, and Calauang, all in La Laguna. In each town several paddies were selected and kept under close observation, and every item of the work and the expense of each was recorded. A brief stay in Pototan, Iloilo, and in Capiz, during the latter part of December, 1914, provided the opportunity to get ample information as to the way in which the same work was carried on in those places. Through correspondence with reliable planters, data from Occidental Negros and Tarlac were also obtained and the cost computed.

Methods of Production

There are two methods of paddy planting in vogue: broadcasting and transplanting. In the former, after the field has been fully prepared, the seeds are scattered more or less uniformly over the field and then left to grow until the grain is ready for the harvest. In a transplanted paddy, several extra operations, besides the preparation of the field, are involved. These are the preparation and planting of the seed bed, pulling off and transportation of seedlings from the seed bed to the paddy, and replanting.

Again the second method is carried on in two distinct ways. These may be distinguished from each other by the mode of seed bed preparation and by the age of the seedling at the time of transplanting. In one of these the seeds are grown in a narrow strip of land not exceeding one meter wide, covered with banana leaves. The seeds sprout on these leaves, and the seedlings are transplanted after seven to ten days, at which time they have a height of 10 to 15 centimeters. This may be termed for convenience, the "short seedling" method, in contrast to the other method which may be termed the "long seedling" method. By the latter method, work is needed for the preparation and planting of the seed bed, besides a longer time for the growth of the seedlings, and a larger tract of land for the bed. The tract selected is plowed, carefully freed from weeds, the surface soil made mellow and fine, and then leveled. In some cases the ground is puddled, after which the seeds are thickly broadcasted. The seedlings are transplanted after six or eight weeks; they are then from 30 to 40 centimeters high.

In Calamba, Calauang, and Los Baños, aside from the methods of planting, the work in the paddy is identical. The different steps of the work are as follows:

I. Plowing: once or twice according to the physical condition of the soil; hard, worn-out soil requires more work.

II. Harrowing: four times.

1. The breaking of clods known as *basag*.
2. Weeding, termed *balasao*.
3. Crosswise harrowing, termed *balagbag*.
4. Leveling, termed *pantay*.

III. Planting: either broadcast or transplanting.

In transplanted paddies the additional work is as follows: In the "short seedling" method one day's work is required for the preparation of the seed bed and sowing of one cavan of seeds. In the "long seedling" method there are: the preparation of the seed bed which consists of thorough plowing and harrowing several times, sowing of seeds, and later, the thinning out of the seedlings.

In Occidental Negros, Iloilo, and Capiz, the common practice is the transplanting of long seedlings. The following are the several steps of the work.

1. Plowing.—The first plowing is in many cases followed by a passage of the harrow, but in most cases not. This depends on the farmer; the common verdict, however, is that some apparent advantage accrues to the farmer who takes this trouble. The second plowing follows the first after an interval of two or three weeks. The second plowing is always followed by a passage of the harrow, after which the land is flooded with the object of rotting out the weeds. This flooding lasts from one to two weeks.

II. Harrowing.—Aside from the harrowing that follows each plowing, the paddy is harrowed three times before planting the seedlings. This is accomplished by letting three harrows work simultaneously, one following the other.

For one hectare of land requiring one cavan of seed, a seed bed ten by sixteen meters is planted. Its preparation is like that of an unsubmerged little paddy, but it requires more thorough work, deeper plowing, more harrowing, weeding by hand, and often the putting up of fences; so that by the time when the seed has been broadcasted, from 10 to 15 days labor have been spent on it.

In Tarlac the common opinion is that the younger the seedlings are when transplanted the better results are obtained; hence, the "short seedling" method generally prevails. Broadcasting is practiced very rarely. After grass and brush have been cut and disposed of by burning, the land is plowed once or twice or even more times, according to the nature of the soil. Plowing more than twice occurs only on lands not previously cultivated, well-kept, irrigated fields requiring but one plowing. Immediately after the plowing, the paddy is flooded for one or two days to soften the plowed surface. The water is then drained off and the land harrowed two to three times until the surface is level and the soil has attained a brothy consistency, after which water is turned in again. The land is then ready for transplanting, except for a last passage of the harrow immediately before that work.

The preparation of the seed bed receives more attention in Tarlac than is usually given to it in Los Baños and Calauang; it takes from 3 to 4 days for one cavan of seeds to be planted on a strip of land 2 by 12 meters. This amount of seed plants one hectare of land.

In broadcast planting all the work is done by men.

An effort has been made to find out from the farmers the reason why some prefer to plant broadcast while others prefer to transplant. It is evident that some saving in seed may be made in transplanting, and that some work is escaped by planting broadcast. The farmers, however, do not profess to take these arguments into account. The only reason they give for the preference of a given method is the inclination of the individual farmer; they say that each farmer, by following his own tastes, can raise a better crop than by any other method. However, a more basic principle than mere taste should govern the work of the farmer; and aside from the simple determination of the cost of production of paddy rice, it is another purpose of this study to find out whether this difference in the method of planting may affect the rate of yield.

It is to be noted that, except in very rare cases, the farmers may be said to neglect their fields from the time of planting to the time of harvest, except that when birds, pests and locusts are numerous they stay in their fields or hire men to drive off the pests. There are rare farmers, who take the trouble to see that the fields are not water-logged and that the rice is not choked up by weeds. If such care be taken, there should be an increase in the yield to offset the added expense. There has been no attempt to ascertain the effect of weeding and so to determine the exact value of this practice.

The work on the paddy is of two kinds: that done with the help of a draft animal, and that done purely by men. The former include plowing and harrowing; and the latter the preparation of the seed bed, the pulling off of seedlings and the transportation to the paddy in the case of "long seedling" planting, and replanting. The pay for work of men and carabao fluctuates with the demand throughout the planting season. In the early part of the season, when only a few farmers are beginning their work, as well as in the last part of the season when only a few farmers need help, the rate of wages is low. The highest wage rate prevails when paddy work is most general. Sometimes wages can be calculated by equivalents only. For example: a farmer may agree to plow or do any kind of work at the rate of one peso a day with meals; that is, the farmer for whom he works provides one or two meals for him each day of work. His wage is equivalent to one peso plus the cost of the food given him. Sometimes a farmer may hire another farmer for a kind of work, agreeing to perform in return the same amount of that work or its equivalent. For instance, a farmer may hire another to plow for one day, and later on he may plow in the other farmer's field for one day, or may transplant or perform some lighter work for more than one day. In the earlier part of the planting season a man working with his own carabao and implements and providing for his

own food may be hired for ₱1.00 or less per day; in the busiest part of the season the wage rises to ₱1.25 or even to ₱1.50 per day. On the average the estimate of the Bureau of Agriculture of ₱1.25 per day for man and draft animal may be followed.

There is a great range in the rate of wages for the work of men alone. In places where labor is organized and such organization can set its own price for the laborer's work, or where such organization is near, the wage rates are much higher than in places where such organization does not exist. In Calauang and Los Baños the day wage is about ₱0.80 for transplanting whether in actual cash or its equivalent; in Occidental Negros, and parts of Iloilo and Capiz the general wage rate for such work is about ₱0.20 per day and meals. In the former, the tendency is to standardize wage by the length of time the laborer works; in the latter places a laborer can receive just as high a wage or higher than in the former, but the wage is gauged by the kind of work performed.

Rental, Taxes, and Interest. Rental and taxes contribute to the cost of production. Interest on the money invested may or may not be treated as a part of the cost, according to the purpose of the study.

Rental.—The renting of agricultural lands takes many forms. Although some land owners rent their lands for money, the greater number prefer to let out their land to tenants on shares, taking a part of the products coming from it. Mr. Zamora informs us that in Tarlac the rental of land is influenced by the fertility of the soil, some land bringing ₱10.00 per hectare, while for others the owner gets one-fourth to one-third of the product. While sharing the product is a general practice throughout the Islands, some land owners save trouble for themselves by requiring from the tenants a fixed amount of rent in the form of product. The Calauang Estate requires each tenant to pay to the estate 10 cavans of rice for every cavan of seed planted, that is, for every cavan area. In Occidental Negros, Iloilo and Capiz, the prevailing method of letting out the land is by sharing the product, the land owner taking one-third, one-half, or two-thirds of the product according to what he contributes besides the land itself. Where a tenant provides nothing other than his work he gets the least amount; where he provides a part of the expenses and implements he gets one-half of the product, or more, according to the extent of his expenditures.

Land, labor and capital are the three recognized factors of production but in the native method of rice production the carabao may make a fourth. This may be understood when other methods of renting land are studied. A land owner may let out land to a tenant in the following manner: The land owner gives the land and all necessary expenses, and the tenant gives his own personal labor and that of his carabao. To the land owner the product represents the returns of his land and capital, and his tenant's labor, but to the tenant the product represents his share of the returns from the land and the labor of his carabao, this animal signifying to him both labor and capital. In fact, a man with initiative, who possesses a piece of well located rice land and a carabao, can raise rice with practically no capital at all except what he needs to buy his seed if he has not saved any. In this connection the carabao's value ought to be taken into consideration, but it cannot be definitely known unless connected with the man's work as previously given. However, in places where carabaos are actually rented, the rent varies from ₱0.50 to ₱1.00 per day for paddy plowing purposes.

In some cases what may be called a "double tenantry" exists. A large estate may let out a large tract of land to a tenant who pays a definite amount of rent. This tenant in turn lets out parts of this land to other tenants under varied conditions. A large tract of the Calauang Estate is worked on this twofold tenant system.

Taxes.—The land tax varies with the value of the land. While it adds an item to the cost of production, this is greatly overbalanced by the normal profits.

Interest.—The interest on the money invested in the paddy field must also be accounted for, for money cannot be put into an enterprise without the expectation that interest will accrue from its use. The interest on the value of the land, except when it is government land which has not yet been fully paid for, is not taken into consideration in the tables to be given since the crop netted by the owner represents the interest on the price of the land. But the land, in order to become a paying investment, must yield a crop which, over and above the actual expenses, should show a gain of at least 10% of its value. In other words, a profit of 10% should accrue from the land yearly. This rate of interest might be considered too high for land investment, but when a detailed study of the existing practices is made it appears low. For example, when a man owning a tract of land borrows money for it, it is a common practice for him to surrender all his rights on the land, except legal ownership, to the lender. After this transaction is over he may work the land under the lender in the capacity of a tenant (as exemplified in Table IV); or

the lender may work the land himself and appropriate all the crops produced. As in an instance where a lender raised in one season a crop to the value of over ₱800.00 from land held in security for a loan of ₱1,500, the rate of interest is nothing short of being appalling. Yet this case is no rarity. Where the crop returns fall short of paying the actual expenses of the planting and harvesting seasons plus 10% of the value of the land the latter cannot be considered as paying returns on the investment.

In the case of government land purchased by yearly installments, when the purchase price is not yet fully paid a question presents itself as to the principal on which interest should be charged which is capable of two solutions: first, from the standpoint of the land owner himself, and second, from that of the community. Data in Tables I and II following are from such lands. The land in Table I has an appraised value of ₱576.96. The holder of the land has already invested in it the sum of ₱287.76, which represents annual installments, taxes and the accruing interest. An item of the cost of production to the land holder is interest on the sum of money already invested, but from the standpoint of the community this interest should be computed on the total value of the land. As this study is concerned chiefly with the cost of production from the land holder's, the land owner's standpoint, the interest on the sum of money already paid for the land is used in the computation; although another calculation of interest based on the total value of the land, is appended to each table. In the first computation the rate of interest has been fixed at 10% as previously assumed, but in the second the rate has been taken as 6%. This is because land not fully paid for is to be considered as being under the divided ownership of the government and of the settler; and that while the interest imposed by the government on land values is only 4%, the holder of the land has to obtain this money outside at a high rate. The total average interest charge is therefore about 6%.

As yet no law adequately regulates the rate of interest in these Islands, hence money lenders practically set their own rates. Many of the common farmers are in such a financial condition that they cannot avail themselves of the advantages given by chartered banks, hence they must comply with the most unreasonable demands of money lenders. For the amounts that these farmers need, the interest charged ranges from 15 to 25%. Sometimes they have to pay more. In many cases they are forced to pawn their crops by promising to pay with rice at a price far less than the prevailing one. For example, a farmer borrows ₱10.00 by pledging his crop at ₱1.00 per cavan. After the harvest he pays 10 cavans, even though rice at the time costs ₱3.00 or over per cavan. For the rate of interest on operating expenses an average of 20% has been used in this paper or for the rice growing season of six months, its equivalent of 10%.

Other Sources of Expense.—Native methods of rice growing are mostly carried on with simple native implements. Native plows and harrows are cheap and with proper care last a considerable length of time. The cost of these implements, with their accessories, to the farmers is about ₱15.00; and for their use ₱1.50 is charged to cover their depreciation within one planting season. This item should also bear interest, as other items of expense.

While the harvest should be treated with other field operations, the peculiar way in which harvest work is paid makes it seem advisable to discuss the item last. The work of harvesting is rarely if ever paid for in cash. Harvesters receive ₱0.50 per day in some parts of Tarlac; but in the places where the actual observations for this work were made, a daily wage is never paid; harvesters are always paid by share, getting a definite portion of the crop harvested. The share ranges from 1/10 to 1/4, being governed by the abundance of the crop and labor supply. A poor harvest, with many harvesters, always brings the least returns to the workers, while with heavy harvests owners can only attract harvesters by giving them a relatively large amount of what they harvest.

The labor of the farmer himself during the harvest is also a proper charge and must be taken into account, even though there is no formal payment of any kind.

Cost of Production

After having made a careful survey of the different steps in growing rice, and of the contribution of labor and other factors to the cost of the product, the profits or losses from different methods of raising rice may be seen from the following tables. These tables are intended to show as many different methods of rice culture, and different problems involved in them, as are available for study.

Tables I and II are data from broadcast paddy planting, under the same natural conditions and practically the same manner of work. The one great difference that they are intended to show is the very marked difference of the cost of the final product raised under different management;

in Table I the owner works the land himself, while in Table II the land is under a tenant.

The actual cost per cavan of yield in both cases is practically the same: ₱1.43 per cavan in Table I, and ₱1.41 per cavan in Table II. There is, however, a difference in the cost of the product to the farmer who owns the land, and the tenant. To the farmer in Table I it costs ₱0.53 less to raise one cavan of rice by owning the land, than it does to the farmer in Table II, who works the land as a tenant. There is also a marked difference in the net cost per cavan to the owner of the land on the one hand and the tenant on the other. To the former the cost of a cavan is only ₱0.74, to the latter ₱1.96, a difference of ₱1.22 per cavan; or, 165% more per cavan to the tenant than to the land owner. With an actual selling price of ₱2.50 per cavan of rice, the farmer in Table I makes ₱142.50 gross from his harvest, or a profit of ₱60.75 over and above his expenses and the interest. The tenant in Table II, at the same rate can make ₱126.25 gross from his share, with a profit of ₱27.29 over and above his expenses. The land owner in letting out his land to a tenant can sell his share at ₱126.25, making a profit of ₱88.88.

TABLE I

DATA FROM BROADCASTED PADDY
(Calamba)

Area: 1.86 Hectares. Appraised value: ₱576.96.

Seed: 2.5 cavans. Amount credited: ₱287.76.

Condition: First class irrigated land; two crops a year. No manuring; no seed selection. Worked by owner himself.

Expenses on the Paddy

On Work:—	
Plowing: 12 days at ₱1.25 per day	₱15.00
Harrowing: 14 days at ₱1.25 per day	17.50
Broadcasting: 1 day at ₱0.80 per day	0.80
Incidental Expenses:	
Interest on the amount credited at 10%, for half year	₱14.39
Cost of seed at ₱3.00 per cavan	7.50
Depreciation on implements	1.50
Interest on total expenses above	5.96
Total expense after planting	₱62.65

Production

Time of harvest: 2 days.	
Total harvest	*57 cavans
Share of harvesters	7 cavans
Net product	50 cavans

Total cost of production

Cost of 7 cavans charged to harvesters at ₱2.50 per cavan (equals the cost of harvesting)	₱17.50
For work during the harvest: 2 days at ₱0.80 per day	1.60
Total expense after planting	62.65
Total cost of production	₱81.75
Cost per cavan of palay produced	₱ 1.43

If instead of the interest on the amount credited by the farmer, a 6% interest on the value of the land is taken as the incidental item of production accruing from it during a planting season this item will be raised to ₱17.31, making the total expenses up to the time of planting ₱65.57, the total cost of production ₱84.67, and the cost per cavan of the palay produced ₱1.49.

TABLE II

DATA FROM BROADCASTED PADDY
(Calamba)

Area: 3.7 Hectares. Appraised value: ₱1,148.00.

Seed: 5 cavans. Amount credited: ₱384.00.

Condition: First class irrigated land; two crops a year. No manuring, no seed selection. Worked by a tenant on condition that he furnish necessary work and expenses; land owner pays yearly installments; each gets half of net product.

Expense to the tenant

Plowing: 24 days at ₱1.25 per day	₱30.00
Harrowing: 28 days at ₱1.25 per day	35.00
Broadcasting: 2 days at ₱0.80 per day	1.60
Depreciation on implements	1.50
Cost of 5 cavans of seed at ₱3.00 per cavan	15.00
Interest on the above at 10%	8.31
Total expense of the tenant after planting	₱91.41

*One cavan is 75 liters of unhulled rice.

Expense to the land owner

Interest on the amount accredited at 10%, for half year	₱19.20
Interest on the above at 20%, for half year	1.92
Total expense of the owner after planting	₱21.12

Production

Time of harvest: 6 days.		
Total harvest	106	cavans
Share of harvesters	13	"
Refund to tenant for seed	55	"
Net product	88	"
Net share of each	44	"
Total share of each	50.5	"

Total cost of production

Cost of 13 cavans at ₱2.50 per cavan	₱ 32.50
For tenant's work during harvest: 6 days	4.80
Total expense of tenant after planting	91.41
Total expense of land owner after planting	21.12
Total cost of production	₱149.83

Total expense of the land owner

Total expense after planting	₱21.12
One-half of the cost of the share of harvesters	16.25
Total cost of production to the land owner	₱37.37

Total expense of the tenant

Total expense after planting	₱91.41
For tenant's work during harvest	4.80
One-half of the cost of the share of harvesters	16.25
REFUND: 5 cavans for seed (at current price)	*12.50
Total cost of production to the tenant	₱98.96
Cost per cavan of palay produced	₱ 1.41
Cost to land owner per cavan of his share	0.74
Cost to tenant per cavan of his share	1.96

If the interest on the appraised value of the land at 6% is used, this item will be raised to ₱34.44. It will then raise the expense of the land owner to ₱54.13, and the total cost of production to ₱166.59. This subsequently changes the per cavan cost of palay as follows: of the total crop to ₱1.57, and of the land owner's share to ₱1.07. The cost of production to the tenant remains unaffected.

*This item is to be subtracted.

Tables III and IV are two farms that were foredoomed bound to lose money for the reason that they had been abandoned to cogon (*Imperata cylindrica*) and talahib (*Saccharum spontaneum*) in previous years, and no water but rain was available at the moment it was needed for the crop. With almost the same areas as in Tables I and II the yields are very far behind those of the latter. The field in Table III actually came short of paying for expenses by ₱13.58. This loss is still further increased by interest, which at the rate of 10% would be ₱20.00, thus making a loss of ₱33.58 to the owner. The field in Table IV gave a total yield of 65 cavans. Of these, two cavans were refunded to the tenant for seeds used. Thirteen cavans went to the harvester; the money value of these constitutes an item of the harvest expenses, which is equivalent to ₱32.50. It is the practice to divide the product equally between the tenant and the land owner after the amount of the seed planted and the share of the harvesters have been taken from the total yield, so that the share of each is 25 cavans. But if cash has been paid for harvesting, instead of a part of the crop, both land owner and tenant receive 6.5 cavans more; the total share of each is therefore 31.5 cavans. At current prices the share of the land owner yields ₱78.75. This represents a gain of ₱37.11 over his actual expenses, but taking into consideration the interest on the money invested in the land, which at 10% is ₱42.00, the land owner actually lost ₱4.89. The tenant for his total expenses of ₱92.83 in both money and labor gets the same quantity of rice, whereby he loses the difference between the selling price of the rice and his expenses, or ₱12.08.

TABLE III

DATA FROM TRANSPLANTED PADDY

"Long Seedling"

(Maahas, Los Baños)

Area: 1.3 Hectares. Cost: ₱200.00.
Seed: 20 gantas or ₱0.80 cavan.
Condition: Newly cleared unirrigated land; one crop a year. No manuring, no seed selection. Worked by owner himself.

Expenses on the paddy

On Work:	
Plowing: 6 days at ₱1.25 per day	₱ 7.50

Harrowing: 15 days at ₱1.25 per day	18.75
Preparation of seed bed and sowing: half day at ₱1.25 per day	0.63
Pulling off of seedlings and transplanting: 10 men at ₱0.60 each per day	6.00

Incidental Expenses:

Land tax	1.75
Cost of seed at ₱3.00 per cavan	2.40
Depreciation of implements	1.50
Interest on the above expense at 10%.	3.45
Total up to transplanting	₱42.38

Production

Time of harvest: 1½ day.

Total harvest	15	cavans
Share of harvesters	3	"
Net product	12	"

Total cost of production

Cost of 3 cavans at ₱2.50 per cavan	₱ 7.50
For owner's work during harvest at ₱0.80 per day	1.20
Total expense up to transplanting	42.38
Total cost of production	₱51.08
Cost per cavan of palay produced	₱ 3.41

TABLE IV

DATA FROM TRANSPLANTED PADDY

"Long Seedling"

(Maahas, Los Baños)

Area: 3.6 hectares. Cost: ₱420.00.
Seed: 2 cavans.

Condition: Newly cleared, unirrigated land; one crop a year. No manuring, no seed selection. Worked by tenant; expenses divided according to items.

Expense to the tenant

Plowing: 13 days at ₱1.25 per day	₱ 16.25
Harrowing: 37 days at ₱1.25 per day	46.25
Preparation and planting of seed bed: 1 day	1.25
Depreciation on implements	1.50
Cost of seed at ₱3.00 per cavan	6.00
Interest on the above expenses at 10%, for half year	7.13
Total expense to the tenant	₱ 78.38

Expense to the land owner

Land tax	₱ 3.68
Cost of two cavans of palay given to tenant	5.00
Pulling off of seedlings and transplanting: 24 men at ₱0.60 per day	14.40
Interest on the above expenses	2.31
Total expense to land owner	₱ 25.39

Production

Time of harvest: 4 days.

Total harvest	65	cavans
Share of harvesters	13	"
Refund for seed	2	"
Net product	50	"
Net share of each	25	"
Total share of each	31.5	"

Total cost of production

Cost of 13 cavans at ₱2.50 per cav.	₱ 32.50
For tenant's work during harvest: 4 days at ₱0.80 per day	3.20
Total expense to the tenant previous to harvest	78.38
Total expense to the land owner previous to harvest	25.39
Total cost of production	₱139.47

Total expense to the land owner

Expense previous to harvest	₱ 25.39
One-half the cost of the share of harvesters	16.25
Total cost of production to land owner	₱ 41.64

Total expense to the tenant

Expenses previous to harvest	₱ 78.38
For tenant's work during the harvest	3.20
One-half the cost of the share of harvesters	16.25
REFUND: For two cavans at ₱2.50 per cavan	*5.00
Total cost of production to the tenant	₱ 92.83
Cost of production per cavan of palay produced	₱ 2.15
Cost to land owner per cavan of his share	2.95

The results obtained by two tenants on an estate where the rent for the use of land is fixed at 10 cavans of palay for every cavan of seed planted are shown in Tables V and VI. While the extent of cultural work in each paddy is

*This item is to be subtracted.

proportionately equal, the low yield in Table V slightly increased the cost of production per cavan of the total yield over that in Table VI. It is after the corresponding rental for the land has been taken from each that a marked change appears, tending to increase the cost per cavan of the net product. In Table V each cavan of the 16 cavans costs the tenant ₱2.82 which is ₱0.32 higher than the current price per cavan of palay. In other words, if the sixteen cavans shared are sold at current price the tenant gets only ₱40.00 which is ₱5.18 less than the value of money and labor he puts into the raising of the rice. The cost of production per cavan of rice in VI is ₱2.08, a margin of ₱0.42 to each cavan produced.

TABLE V

DATA FROM TRANSPLANTED PADDY

"Short Seedling"

(Calauang Estate, Calauang)

Area: 0.8 hectare.

Seed: 1 cavan.

Condition: Irrigated land, two crops a year. No manuring, no seed selection. Worked by a tenant.

Expenses on the paddy

Plowing: 6 days at ₱1.25 per day	₱ 7.50
Harrowing: 11 days at ₱1.25 per day	13.75
Preparation and planting of seed bed: 1 day	0.80
Transplanting: 8 men at ₱0.80 per day	6.40
Cost of seed: 1 cavan	3.00
Depreciation of implements	1.50
Interest on the above expenses at 20%, for half year	3.30
Total cost of paddy previous to harvest	₱ 36.25

Production

Time of harvest: 1 day.		
Total harvest	26	cavans
Rent on land	10	"
Share of harvesters	3½	"
Net product	12¾	"
Total share of tenant	16	"

Total cost of production

Cost of 3½ cavans at ₱2.50 per cavan	₱ 8.13
For tenant's work during the harvest	0.80
Total expense on the paddy previous to the harvest	36.25
Total cost of production	₱ 45.18
Cost per cavan of palay produced	₱ 1.74
Cost to tenant per cavan of his share	₱ 2.82

TABLE VI

DATA FROM TRANSPLANTED PADDY

"Short Seedling"

(Calauang Estate, Calauang)

Area: 2.2 hectares.

Seed: 3 cavans.

Condition: Irrigated land; two crops a year. No manuring, no seed selection. Worked by a tenant.

Expenses on the paddy

Plowing: 18 days at ₱1.25 per day	₱ 22.50
Harrowing: 35 days at ₱1.25 per day	43.75
Preparation and planting of seed bed 2 days	1.60
Transplanting: 40 men at ₱0.78 per day	31.20
Cost of 3 cavans of seed at ₱3.00 per cavan	9.00
Depreciation on implements	1.50
Interest on the above expenses at 20%, for half year	10.96
Total expenses on the paddy	₱120.51

Production

Time of harvest: 4 days.		
Total harvest	105	cavans
Rent of land	30	"
Share of harvesters	13	"
Net product	62	"
Total share of tenant	75	"

Total cost of production

Cost of 13 cavans at ₱2.50 per cavan	₱ 32.50
For tenant's work during harvest	3.20
Total expense previous to harvest	120.51
Total cost of production	₱156.21
Cost per cavan of palay produced	₱ 1.46
Cost of tenant per cavan of his share	₱ 2.08

Mention has been made of double tenantry. Data for the work under this system are given in Tables VII and VIII. In each of these the head-tenant pays the estate a definite amount of rent, namely: in VII, 33 cavans; and in VIII, 33.5. To the sub-tenant the head-tenant agrees to furnish all the expenses incurred under the following items; for the seed, expenses in the pulling off of seedling which comprises wages and food for the hired laborer, expenses in transplanting which include wages and food for the

transplanters, and the use of a carabao. The sub-tenant agrees to do the rest of the work. The head-tenant and sub-tenant also agree that after the share of the harvester has been taken away from the total harvest, a portion of the remaining palay equal to the amount of seed used, and another portion equal to the amount of the rent are futher to be taken out. After these have been subtracted, the remainder of the crop is to be equally divided between them; and, the sub-tenant pays out of his share, to the head-tenant all the expenditures incurred.

TABLE VII

DATA FROM TRANSPLANTED PADDY

"Long Seedling"

(Calauang Estate, Calauang)

Area: 2.4 Hectares.
Seed: 3 cavans.
Condition: Irrigated land; two crops a year. No manuring, no seed selection. Double tenant system.

Expenses on the paddy and seed bed

Plowing: 16 days at ₱1.25 per day.	₱ 20.00
Harrowing: 36 days at ₱1.25 per day	45.00
Preparation of seed bed: 3 days at ₱1.25 per day	3.75
Sowing, and fencing about of seed bed: 3 days	2.40
Pulling off of seedlings; wages and food expenses	9.30
Transplanting: wages and food expenses for 36 workers for one day at ₱0.50 per day	22.30
Interest on the above expenses at 20%, for half year	10.28
Total expense on the paddy previous to harvest	113.03

Production

Time of harvest: 4 days.		
Total harvest	105	cavans
Refund for seed	3	"
Share of harvesters	12	"
Rent for land	33	"
Net product	57	"
Net share	28.5	"
Total share of each (head-tenant)	34.5	"

Total cost of production

Share of harvesters: 12 cavans at ₱2.50 per cavan	₱ 30.00
For sub-tenant's work during harvest: 4 days	3.20
Total expense on the paddy previous to harvest	113.03
Total cost of production	₱146.23
Cost per cavan of palay produced	₱ 1.39

TABLE VIII

DATA FROM TRANSPLANTED PADDY

"Long Seedling"

(Calauang Estate, Calauang)

Area: 2.4 hectares.
Seed: 3 cavans.
Condition: Irrigated land; two crops a year: no fertilizer; no seed selection; under a double tenant system.

Expenses on the paddy and seed bed

Plowing: 15 days at ₱1.25 per day	₱ 18.75
Harrowing: 40 days at ₱1.25 per day	50.00
Preparation of seed bed: 3 days at ₱1.25 per day	3.75
Sowing the seeds and fencing about of the seed bed: 3 days at ₱0.80 per day	2.40
Pulling off of seedlings: wages and expenses for food of workers	9.01
Transplanting: wages and expenses for food of 36 men, wage rate at ₱0.50 per day	22.51
Interest on the above expenses at 10%	10.64
Total expense on the paddy after planting	₱117.06

Production

Time of harvest: 4 days.		
Total harvest	139	cavans
Refund for seed to head-tenant	3	"
Share of harvesters	17.5	"
Rental	33.5	"
Net product	88	"
Net share	44	"
Total share of each	52.75	"

Total cost of production

Share of harvesters: at ₱2.50 per cavan (17.5 cavans)	₱ 43.75
For tenant's work during the harvest: 4 days at ₱0.80 per day	3.20
Total expense previous to harvest	117.06
Total cost of production	₱164.01
Cost per cavan of palay produced	₱ 1.18

Tables VII and VIII show the cost of production per cavan of the total product. In order to find out the profit per cavan netted by the head-tenant and the sub-tenant the different items which belong to each in the total cost must be separated.

Although the sub-tenant furnishes nothing but personal work up to the completion of planting, he has to pay back all the expenses to the head-tenant. In reality, then, the sub-tenant is the one who has provided for everything to carry out the work except the use of the carabao; the only expense incurred by the head-tenant was this use plus the interest for the money he advanced. The amount of this expense may be determined as follows: The work of man and carabao is worth ₱1.25 per day, and subtracting from this the man's wage of ₱0.80, the value of the animal's work is obtained. From the table the exact number of days the carabao was used is indicated.

The expense to the head-tenant is as follows:

	In Table VII	*In Table VIII*
Number of days the animal was used	55	58
Rate per day	₱ 0.45	₱ 0.45
For the use of Carabao	24.75	26.10
Interest on money advanced	3.16	3.15
One-half of value of the share of harvesters	15.00	21.88
Total expense to head-tenant	₱42.91	₱51.13

The total expenses to the head-tenant, then, including one-half of the value of the share of the harvester are indicated. Subtracting these amounts from their corresponding total expense gives the expenses of the sub-tenant; to wit: in Table VII equals ₱103.32, and in Table VIII equals ₱112.88.

The tables show the total amount of the share of each. The cost of production per cavan of these is:—

	In Table VII	*In Table VIII*
To the head-tenant	₱ 1.24	₱ 0.97
To the sub-tenant	2.99	2.14

These figures are full of meaning. From what they show may be judged the merits or demerits of twofold tenantry.

In Occidental Negros, Iloilo and Capiz, as far as available data can show, the expenses incurred by a farmer for one hectare of land ranges from ₱45.00 to ₱60.00, inclusive of the tax on the land. The figures fit also the expenditures of farmers in Tarlac working on irrigated paddy land. With harvest from such fields ranging from 25 to 35 cavans of palay, a very slight margin of profit is possible to the farmer. But it must be remembered that in those places, the same as in places where actual observations were made, the tenant system of farming prevails. Under such system, a slight margin of profit in the whole crop can mean nothing less than a loss to the tenant, hence tenants there may just as well join hands with tenants in Los Baños and Calauang and declare their labor in the raising of rice unprofitable.

Summary.—All the fields represented in the preceding tables had a total area of 18.26 hectares, were planted to 20.3 cavans of seeds, and produced 620 cavans of palay. With an average of 1.1 cavans planted the hectare of land produced an average of 34 cavans, ranging from 11.5 cavans to 58 cavans. Figuring on the finding of the Bureau of Agriculture that one cavan of palay gives 28 kilos of rice, these paddies produced an average of 950 kilos of cleaned rice to the hectare, ranging in different places from 320 to 1,620 kilos, the highest yield being about equal to the average production in the United States. The lands treated here, however, are mostly irrigated lands and do not represent well the general conditions throughout the country. This explains the difference in the average yield and that obtained by the Bureau of Agriculture, which was used to compare with the average production of other countries.

In the following table, this explanation of columns is needed:

A. Tables.
B. Total yield.
C. Yield per hectare.
D. Total expense.
E. Cost per cavan of the crop.
F. Total expense of land owner.
G. Total expense of tenant.
H. Total expense of head-tenant.
I. Cost per cavan to land owner.
J. Cost per cavan to tenant.
K. Cost per cavan to head-tenant.

A	B	E	D	E	F	G	H	I	J	K
I	57	30.6	₱ 81.75	₱1.43						
II	106	28.6	149.83	1.41	₱37.37	₱98.96		₱0.74	₱1.96	
III	15	11.5	51.08	3.41						
IV	65	18.0	139.47	2.15	41.64	92.83		1.32	2.95	
V	26	32.5	45.18	1.74					2.82	
VI	105	47.7	156.21	1.46					2.08	
VII	105	43.7	146.23	1.39		103.32	₱ 2.91		2.99	₱.24
VIII	139	57.9	164.01	1.18		112.88	51.13		2.14	0.99

The very marked difference in the returns of the irrigated and unirrigated lands as shown by Tables I and III respectively, is significant and instructive. Where the farmer has to gamble with nature in his effort to provide food not only for himself but for the whole community in which he lives, there are times when he may succeed; but there are times also when he must fail and not only he, but the community, has to go hungry. But the providing of an adequate water supply is a thing which one common farmer, or a small group of them, can scarcely hope to accomplish by themselves. In the place where the data for Tables III and IV were obtained the farmers interested tried to run their own irrigation system. They erected a dam just below the College grounds, to make a reservoir; but, their canal overflows during the rainy season, and becomes almost dry when they most need water. The providing of an adequate water supply is something beyond reach of the small farmers, and something they must look up to a stronger organization to provide; the community for which he works and which depends upon the results of his labor must therefore help, and this help the smaller farmers hope to see provided by the community's great agent, the government.

It is to be noted that the highest yield obtained in one of these fields (Table VIII) falls far short of the average production in Japan. Where water in this case is let into or shut off from the field at will, in many rice fields in Japan water has to be brought to the fields with utmost difficulty. The governing factor of this difference then does not lie on the water needs of the plants. It is in the care which farmer puts on the management of the fertility of his soil. While the Japanse farmer applies all sorts of available plant food to his soil—garbage, animal manure, decaying vegetable matter, and dried grass and weeds —the common farmer in this country does nothing of the kind but gives his field to cogon and talahib part of the time. These he cuts previous to his plowings, permits them to dry, and burns them. It is evident that not only has the plant food in the soil been taken up by these weeds to be given up to the air in burning, but the fire itself actually burns the humus in the surface soil, rendering it useless for the use of his crops. Soil fertility then accounts for this difference. It may not be advisable as yet to oblige the common farmer to use commercial fertilizers, but the lessening of the cost of producing the unit amount of rice by increasing the crop can be accomplished by applying natural manures and ashes. The rotation of crops with legumes is a profitable practice that also helps in restoring in a way the lost soil fertility. Burning should be done away with entirely.

Another cause of the difference between rice production is such countries as Spain and Italy, and that in this country is seed selection. In Spain where high yields per unit area are already assured by the greatest care being given to the preparation of the fields and seed nurseries, to their being highly manured, and to the careful control of water, the farmers add greatly to their yield by the painstaking selection of seeds from standard varieties of already known productivity, as well as by the acclimatization of new forms which are constantly being introduced from other countries, with a view to determining their productivity. In this kind of work Spain and Italy lead. Experiment stations have been established where such work is carried out, and farmers find that they pay. In this country the farmers are content to take their seed from the common crop. Work in seed selection has been carried on by the Bureau of Agriculture under the direction of Mr. Jacobson, and the results obtained promise great success. By seed selection Mr. Jacobson has isolated a strain which yields upwards of 150 cavans to the hectare (planted 20 by 20 cm.). If the farmers of this country can approach this result, it will not only mean the salvation of the country from the further importation of rice but it will mean the writing of the account on the other side of the ledger,—bringing a state of well-being and contentment where there is now a good deal of

poverty and discontent. An increase in area is not wanted since animals could not be found to work it, nor is it needed if the present area could be brought to anything like a fair productiveness.

Of the results recorded in the tables only one (Table III) showed returns too low to pay for actual expenses, but this was doubtless due to the exceptional disadvantages in the location and other conditions in the field. All the rest, except Table IV, gave in the general crop, a profit which ranges from 30 to 52%. However, it is in the final partition of the products between land owners and tenants that the unfortunate part of the story shows itself, for after all, the apparent profits that are shown by the general crop became in many cases (Tables IV, V, VII), a loss to the actual tiller of the soil. Only the farmer in Table I escaped this unfair exchange of values by being the owner of his land; and, in all cases, except in Table III, the land owners and head-tenants made the profit ranging from 45 to 70% as against the tenant's profit of 20% or actual loss.

These facts speak for themselves. They show that among all the factors that govern rice production there is a social economic one which greatly needs improvement. Time and again a cry is raised concerning the indolence and improvidence of the Filipino farmer, who goes hungry half of the year. That the Filipino farmer can favorably compare with the producers in other countries after he has been trained, cannot be doubted. But it does not matter how much rice he produces from the hectare of land, if he is unprotected from the usurious clutch of the money lender or of the land owner or of the head-tenant, he cannot become well-to-do but must always remain a miserable tenant. Yet this same improvident small farmer produces the bulk of the wealth of the Filipino people. There is only one visible way by which this situation may be remedied, and that is by giving the small farmers due protection under favorable laws. He has no access to any bank to which he may look for help in financing his operations. The Agricultural Bank, apparently, does not yet reach him. Hence in order for him to produce his crop he is forced to submit to the exorbitant charges of those who are greedy to profit by his efforts. The farmer must bear the burden of feeding the whole population. He needs governmental protection and it must be given to him. To this end he must not be made the recipient of governmental gratuities, but must be provided only with a fair and honest chance to reap the fair rewards of his work. The conditions that bind him in economic slavery must be banished. Once economically free, he will by his own efforts command the respect of the world.

Recommendations

If the production of rice is to become a profitable industry for the Filipino farmer a great many facts will need to be collected with regard to the various influences that control productiveness. The investigation that ought to be carried out will take six principal directions:

1. A study of the different methods of planting rice, to determine which is the best.

2. A study of the effects of different spacing in transplanting different varieties with different soils, to determine distance between plants that gives the optimum yield. With this may be included a determination of the optimum number of plants that should go into each hill.

3. A study of the control of water in the paddy.

4. A study of the effects of different fertilizers on different kinds of soils for different varieties.

5. A study of the destruction caused by insects and other pests on rice, and their control.

6. A detailed study of which the present paper will serve as an introduction of the relation of the tenant to the land-owner with a view of improving the economic condition of the former.

Conclusions

1. The fields taken in this work yielded a total crop of 620 cavans at the total expense of ₱964.70. This makes the cost of production ₱1.56 per cavan.

2. In tenant work the profit goes to the land owner, or, in case of double tenantry, to the land owner and the head-tenant. This speaks in favor of the absolute ownership of the land (Table I) if a farmer expects to raise rice under the present system.

3. Even absolute ownership of the land does not insure profit (Table III) unless such land is naturally well located with regard to water supply. The small farmer alone can usually do absolutely nothing toward providing an efficient irrigation system, and the lack of this only tends to increase the cost of rice production as a whole.

4. It is the exorbitant interest rates imposed upon the small farmer that most increase his

cost of producing rice. To remedy this, laws should be enacted to penalize such exorbitancy; or, better yet, means should be devised, either through the agency of the agricultural societies, or through municipal governments, which will enable the small producer to borrow money without cutting into his just returns for honest work.

5. Every effort should be made to improve and fix the productive qualities of native rice by seed selection. These results should be placed within the reach of the common farmer by free distribution or by sale at reasonable cost.

6. The common farmer must be educated to appreciate and realize the importance and the greater possibilities of his profession. This may be accomplished by the efforts of government demonstrators or agricultural societies, or by agricultural students who are able to do much to improve the methods in vogue in their home provinces.

PARTIAL VIEW, COLLEGE NURSERY

The Philippine Agriculturist and Forester

Twenty-five centavos a Copy. Two pesos a year

Foreign Subscription 1.50 dollars a year

Published by the Student Body of The Philippine College of Agriculture

Entered at the post-office at Los Baños, Laguna, as second class mail matter

Vol. IV **May, 1915** **No. 2**

NEMESIO MENDIOLA, *Editor-in-Chief*
LEOPOLDO UICHANCO, LEOPOLDO MENDOZA, *Assistant Editors*
DOMINGO B. PAGUIRIGAN, *Business Manager*
BLAS VELEZ, FELIX SARAO, *Assistant Managers*

FOREST RANGERS GRADUATE

The graduating exercises of the students in the forest ranger's course in the College of Agriculture were held at the College in Los Baños the afternoon of Friday, March 19th. The address of the afternoon was expected to be given by the President of the University. In his absence, the Dean gave a talk to the class on the opportunity of the forest service to promote the economic welfare of the people in a field much broader than that in which the official duties of the staff will require service, and illustrated the situation by observations made on his recent trip to Java. Forestry in Java, where the productive natural forests have almost entirely given way to agriculture, still demands the service of more than twelve hundred classified employees, and pays net revenues to the State of about two and a half million pesos. But this revenue to the Government is insignificant compared with the service of forestry to the people, in supplying them with teak at such a price that it is the universal structural timber of the island. In this way, the tremendous waste which the people of the Philippines suffer from the destruction of the less durable building materials used here is almost entirely avoided. The Director of Forestry gave one of the best addresses to the graduating class ever heard on this campus.

The graduating rangers of this year are the best class in scholarship that has so far been graduated. Those who have particularly distinguished themselves are Carlos Sulit of La Laguna, who received the Ahern medal, Soong Ding Moo of Shanghai, China, who has done in two years more than the regular work of the course, and secured high grades; Macario Mariano of Pangasinan, first honor student, and Calixto Mabesa of Occidental Negros, second honor student.

The list of graduates is as follows:

Felipe R. Amos	Pastor de la Peña
Felix Bawan	Jose Phasis
Vicente Ceballos	Julian Sandique
Juan Catalan	Antonio Samonte
Mariano Jurado	Carlos Sulit
Jose Lazaro	Teodoro Tecson
Calixto Mabesa	Bernardo Tocmo
Macario Mariano	Probo Villanueva
Gregorio Miras	Soong Ding Moo

Bamboo Planting at the College of Agriculture

By ANICETO VILLAMIL

Ranger, Bureau of Forestry

The local supply of bamboo for structural purposes has been markedly inadequate for some time past. There is also a great dearth of information concerning the cost of planting bamboo, the care necessary to obtain the best results with it, and the time required to obtain a crop from planted material. In order to obtain some information on these subjects, it was decided to undertake the planting of a bamboo plantation.

The plan for this work was made by Forester H. M. Curran and the work was carried out by Rangers De Mesa and Villamil.

The material selected for planting was from shoots of 1 to 2 years or older, from poorly grown shoots that were overtopped and not well supplied with light, and from upper twigs. A few butts were taken also. Butts less than one year old were taken. The length of cuttings used was from 60 cm. to 2 m. In the selection of cuttings, care was taken to avoid injury to the clump. This selection of cuttings required more care than did any other part of the work. Most of the material selected was of *Cauayan* (Bambusa *blumeana*), the ordinary thorny, structural bamboo. Enough material of the large smooth bamboo (Bambusa *vulgaris*) and of one kind of *caña boho* (Gigantochloa *scribneriana*) was selected to make sample plots of those kinds of bamboo.

The cuttings were collected from 3 to 36 hours before planting, and were laid in the water at the edge of the river, whenever it was not possible to plant them immediately. During the time that this work was being done, the weather was very rainy, so there was less than the usual amount of drying out.

The total time consumed in the collection of cuttings was 200 hours.

Planting:—The place chosen for the plantation was the rough river banks along the Molauin and Pili Rivers and between these two streams. The slope is very steep in some places and the whole area is rough. More than half the area (12,058 sq. m.) was covered with a dense undergrowth of *parang* trees, tall grasses and climbing bamboo, with a few large trees. The small brush and the climbing bamboo were cut over. Some of the larger brush was left to shade the young plants.

Planting was done between the dates of August 29 and October 10, 1912. The tools used were mattocks and heavy pointed sticks. The mattocks were used when rocky soil was encountered or when very large pieces were to be planted. The greater part of the planting was done on rainy days, when the ground was soft, the heavy sharpened stick being used to make the holes. After the cutting was placed in the hole made for it, the soil was tamped in firmly about it.

The following table shows the kind and amount of planting and the spacing that was used:

Kind of Cutting	*Number planted*	*Area Sq. m.*	*Distance meters.*
Thorny	325	5200	4
"	226	8136	6
Thorny	448	4032	3
"	16	576	6
Smooth	145	1305	3
Boho	105	945	3
TOTALS	1265	21194	

Time employed in planting	140 hours.
Time employed in clearing	207 "
Time used in selecting cuttings	200 "
TOTAL TIME	547 hours.

Assuming that labor costs 10 centavos per hour, the cost of the plantation would be ₱54.70. This is at the rate of ₱25.85 per hectare, or ₱10.54 per acre.

On October 31, three weeks after the completion of the planting, 89% of the cuttings were alive.

Care of the Plantation:—The only care that has been given the plantation has been a cutting over of the brush and climbing bamboo during each dry season.

Most of the young twigs have failed. The larger pieces have done much better. Stumps, though much harder to prepare, give a much more prompt growth and will probably prove to be cheapest in the long run.

During the rainy season of 1913, blanks in the plantation were filled. On January 10, 1914, there were alive in the plantation 349 plants of the original planting of *Cauayan*, 46 of the smooth bamboo, and 6 of the *boho*. Of the 1913 planting, 136 Cauayan were alive, 50 dead and 8 doubtful. That is 31.7% of the original planting was alive and doing well on that date. During the following dry season, a grass fire entered the edge of the plantation and killed a number of young plants. On December 1, 1914, 342 plants of *Cauayan*, 65 of the smooth bamboo, and 6 of the *boho* were alive and flourishing.

The present condition of the plantation is very promising. Vigorous shoots have been sent up by each clump; but it is not yet possible to say how long it will take for the clumps to reach maturity.

Recommendations:—In future planting, only large pieces, two or three internodes in length should be used. It is better if these are from the butt end of the culm and have roots appearing at the lower nodes. The planting should be done as early as possible in the rainy season. The planters should be furnished with steel-shod wooden dibbles. These should be pointed at one end for making the holes, and blunt at the other end so that they can be used in tamping.

Some Experiments in Pineapple Planting

By Severo Medinaceli Capistrano

Thesis presented for graduation from the College of Agriculture, No. 29

Introduction

The pineapple *Ananassa sativa* Lind, also known as *Bromelia ananas* Linn., belongs to the family Bromeliaceae.

It is of American origin, and was formerly confined mainly to South America. The discovery of the pineapple was coincident with the exploration of South America by the Spaniards (1). The first pineapple introduced into Europe was from Peru. It was called "Nanas," whence the name Ananassa. Andres Thevet gave a description of it in 1555 (2).

The pineapple was introduced into the Philippines by the Spaniards but the exact date of its introduction is not known. It is widely scattered throughout the different islands of the Archipelago, and is known by the Spanish name of *Piña*. It is so well adapted to most places in the Archipelago that it is commonly found growing wild. At present there are very few large plantations. It is planted only to meet the demands for the fruit and for the fiber from which cloth is made.

The importance of pineapple growing as an industry for the Philippines is becoming better known to the local public. The United States is importing millions of dollars worth of pineapples yearly. The Straits Settlements, a country not far from the Philippines, is annually exporting millions of canned pineapples to England and the European continent (3). Hawaii, Porto Rico, and Cuba are doing the same. The production is increasing every year, but is always behind the demand (4).

Pineaple Industry in Other Countries

Pineapple growing is a new industry in Hawaii, but Hawaii is now one of the largest pineapple producers, and Honolulu is said to have the largest pineapple cannery in the world. The pineapple exports of Hawaii to the United States have been as follows (5):

year	*value*
1911	$1,855,046
1912	2,275,605
1913	3,315,715

The canning industry is increasing in Porto Rico. Canning factories are being built wherever pineapples are grown. Fruits that are unfit to can are made into cider and denatured alcohol. The pineapple exports of Porto Rico to the United States have been as follows (5):

year	*value*
1911	54,186
1912	163,978
1913	58,611

The pineapple has been grown in Cuba for a long time, but there the industry has never been highly prosperous, and there is no pineapple cannery. The exports of pineapples from Cuba, as given by Señor Manuel Ecay, Director of the Department of Statistics of the Revenue Department, were as follows (6):

year	*kilos*	*value*
1906-1907	18,831,165	$ 710,309
1907-1908	23,634,395	910,474
1908-1909	31,009,933	1,221,210
1909-1910	32,851,340	1,303,698
1910-1911	25,785,314	878,145

The above data show that the pineapple industry in Cuba may yet attain large proportions. The exports for 1912 and 1913 were 1,208,450 and 1,501,588 crates respectively (7).

Pineapple Growing in the Philippines

The leading pineapple districts in the Island of Luzon are the Provinces of Bataan, Bulacan, and Nueva Ecija. The chief pineapple-producing towns are Orion in Bataan, Bulacan and Malolos in Bulacan Province, and Cabanatuan in Nueva Ecija. This industry ranks third among the industries of these places. In Orion, the barrio of Damulog is wholly occupied with the growing of pineapples. In the municipality of Bulacan the barrios of San Nicolas, Balubad, Tibig, Pitpitan and Tabang are growing pineapples very extensively, as is also the barrio of Santa Isabel in Malolos.

The variety grown in Santa Isabel and Bulacan has much smaller fruit than that grown in Orion, but the Santa Isabel and Bulacan variety is sweeter. There are four varieties of pineapples grown in Santa Isabel and Bulacan, namely, the Costa, Señorita, Tagalog, and Baboy. Of

these four varieties Costa is considered the best, and second to this is the Señorita. The latter has yellowish flesh and small eyes and the fruit is smaller than that of the Costa. The Tagalog ranks third, and Baboy last. Costa is grown most extensively, the next being Señorita.

No fertilizers are used in any of the plantations nor is cultivation practised. The plants are set without leaving any pathway between the rows, so that when the pineapples are fully mature and rattoons, suckers, and shoots are produced, a veritable thicket is formed. The harvesting of the fruits is then very difficult.

About 613 hectares of land were given to pineapples in all the Islands in 1903. This area produced about 952,400 fruits and 292,400 kilograms of fiber. The average production was 1,500 fruits and 475 kilograms of fiber per hectare. The following table shows the provinces in which the yield of fibers amounted to 15,000 kilograms or over, (1908), (3):

TABLE I
YIELD OF PINEAPPLE FIBER IN THE PHILIPPINE ISLANDS

Order	*Provinces*	*Area cultivated (hectares)*	*Fiber produced (kilos)*	*Average per hectare (kilos)*
1	Negros Occidental	41	46,000	1,122
2	Samar	51	30,229	593
3	Bulacan	31	18,400	594
4	Cebu	25	17,296	692
5	Leyte	29	17,086	589
6	Laguna	25	15,772	631
7	Batangas	27	15,114	560

The provinces in which the production of fruits amounted to 20,000 and over (1908) are listed in the following table:(3)

TABLE II
YIELD OF PINEAPPLE FRUITS IN THE PHILIPPINE ISLANDS

Order	*Provinces*	*Area cultivated (hectares)*	*Fruits produced*	*Average per hectare (fruits)*
1	Samar	51	93,000	1,824
2	Bataan	30	46,620	1,554
3	Occidental Negros	41	44,400	1,083
4	Tayabas&Marinduque	41	42,000	1,024
5	Cebu	25	31,200	1,246
6	Leyte	29	25,700	886
7	Bulacan	31	24,900	803
8	Zambales	12	22,700	1,892
9	Cagayan	17	21,300	1,253

In 1913 it was reported that the pineapples were very promising in Cabanatuan, Nueva Ecija, and that a pineapple cannery was under construction and would soon be ready for operation.

Propagation and Cultivation

The pineapple is propagated in six different ways, namely, by rattoons, suckers, slips, crown slips, crowns and stumps. The rattoons are the young shoots which are found below the soil, while those in the axils of the leaves are called suckers. The plantlets that are produced on the fruit stalk below the fruit are called the slips. The crown is the tuft of leaves at the apex of the fruit, and the crown slips are the slips that are found beneath and around the crown. The stumps are the bases of old plants. Nearly all varieties of pineapples produce seeds, but the latter are rarely planted, except for experimental purposes or for breeding new varieties.

Pineapples will grow on any kind of soil provided it is well drained. Good drainage is absolutely necessary. Sandy open soil is best for this plant. In Cuba, in the most famous pineapple district, the pineapples are grown on red soil containing gravel and sand. In Florida good plantations are found on the lightest of sandy soil, though in Hawaii vast plantations are located upon very heavy soils. It is not the content of the soil in the mineral elements of plant food humus that is important to the pineapples, so much as free drainage. The pineapple soils on the Florida mainland, as shown by analysis, are deficient in the ordinary nutrients (8).

Pineapples are planted in single rows or in several rows, in ridges or on the level ground, but the method to be used depends upon the character of the land.

In the single row system the beds are laid off by throwing together two furrows, forming a ridge. Practically no hand work is done. The plants are set from 30 to 60 centimeters apart in rows from 60 to 180 centimeters apart. This system is not adapted to light sandy nor to too heavy clay soils on account of drying out. There is no objection to the one row system in narrow beds, if it be used in a friable loam. In the wide rows the cultivation can be done with a horse cultivator. Where the land is very weedy, this is the best system to use. The great objection to this system is that as soon as the fruit gets to a considerable size, it bends over until it touches the ground. It is then subject to sun scald. This is especially true in the large-fruited varieties.

In the double row system the plants are set from 30 to 60 centimeters apart each way leaving a margin of at least 15 centimeters on each side. Beds are made by plowing several rows together. These require hand work in finishing. This method is adapted to any kind of soil and has nearly all the advantages of the single row system. The falling over of the plants and fruits is minimized. The two row system is to be used where the land is weedy.

In soils free from weeds, and in heavy clay or sandy soils, the three or six row system may be used. In preparing these beds, the same method can be used as in the single and double row systems. Considerable hand work is required with these systems. The plants are set from 40 to 60 centimeters apart, with a margin of 15 centimeters or more on each side of the bed. A pathway of 180 centimeters should be allowed between the beds.

The wide-bed or Florida system is only used in Florida. The plants are set from 45 to 55 centimeters apart, with a roadway of 240 centimeters.

The approximate number of plants per hectare for the different systems of planting is given in the following table (9):

TABLE VI

SHOWING NUMBER OF PLANTS PER HECTARE

System of Planting	*Varieties*	*Distance apart of plants in rows*	*Width of path between beds*			
			1 m.	*1.30 m.*	*1.50 m.*	*2 m.*
Single row	Small	30	33,333	25,641	22,222	16,666
	Large	40	25,000	19,230	16,666	12,500
Double rows	Small	30 by 40	50,949	41,625	36,963	28,638
	Large	40 by 40	35,250	29,250	26,250	20,750
Three rows	Small	40 by 40	41,250	35,250	32,250	26,250
	Large	50 by 50	30,000	25,800	24,000	19,800
Four rows	Small	50 by 50	32,000	28,000	26,400	22,400
	Large	60 by 60	23,240	21,248	19,920	17,264
Five rows	Small	50 by 50	33,000	30,000	28,000	25,000
	Large	60 by 60	24,070	22,410	20,750	18,260
Six rows	Small	50 by 50	33,600	31,200	30,000	26,400
	Large	60 by 60	24,900	22,908	21,912	19,920
Thirty rows	Small	50 by 50	38,400	37,800	36,000	37,200
	Large	60 by 60	28,892	26,394	23,900	25,398

EXPERIMENTS AT THE COLLEGE OF AGRICULTURE

Certain experiments have been carried on by the writer with the following objects:

1. To test the varieties known elsewhere in the Islands side by side with the varieties formerly grown here.
2. To compare planting in furrows and on ridges.
3. To test the effect of irrigation.
4. To determine the effect of certain manures.
5. To compare rates of growth in all of the above.
6. To determine the season of most rapid growth.
7. To discover if possible the effects on the flowering of manuring and the planting in furrows and on ridges.
8. To compare the rattoons, suckers, slips and crowns, as planting stock.

The varieties under experiment with their permanent numbers in the College records were as follows: Smooth Cayenne, 302; Sugar Loaf, 558; Hawaii, 275; Japanese pineapple, 297; Costa, 1830; Baboy, 1831; Los Baños variety, 1832; College variety, 1833; the Calawang variety, 2335; rattoons, suckers and slips of College variety, 157.

The stock of the Smooth Cayenne and the Hawaiian variety was from Hawaii, that of the Japanese variety from Japan, that of the Costa and the Baboy from Malolos, and that of the Sugar Loaf, from the Lamao Experiment Station.

In preparing the plants for setting, a few of the leaves at the base were pulled off. Care was taken not to pull off too many and thus expose too much of the tender portions of the plant. Trials were also made leaving all the leaves at the base. It was found that it took a very long time for the roots to develop, and the growth was retarded. Growth began in 73 to 103 days. The trimmed ones took root much more freely and earlier, and active growth began within two months.

Five and one-half plots were taken for the writer's experiments. Each full plot was 1-200 of a hectare. Halves of four plots received ten wheelbarrows of stable manure. The soil in all the plots was turned to a depth of about 25 centimeters and then pulverized. Some of the plots were made into ridges of about 20 centimeters in height and about 40 centimeters in width at the base, and the others into furrows about 15 centimeters in depth. The soil of all these plots was a clay loam.

Large pineapple plants were gathered around the College farm and at Los Baños. These were then planted in furrows, and in ridges. The planting began on April 8, 1913. On account of the difficulty in collecting the plants, they were not planted at the same time. Suckers, slips, crowns, and rattoons of the native varieties, and eight Smooth Cayenne were planted on May 1 in furrows and ridges, manured and unmanured. Slips of the Sugar Loaf were also planted. On May 29 another set of suckers of Smooth Cayenne were planted. All of these plants were planted in rows 70 centimeters apart and about 50 centimeters in the row. The Costa and Baboy were also planted in furrows and ridges manured and unmanured at distance of 1 by 1 meter. These were set out on May 3. One-half of the unmanured furrows were planted with slips and large plants of Sugar Loaf and Smooth Cayenne on July 8.

Pineapple plants need little cultivation, but they must be kept free from weeds. The result of years of experience in the sandy region of South Florida show that very little care need be taken in cultivation. It is the practice there to cultivate the soil to a depth of about an inch with a scuffle hoe three or four times a year.

The pineapples under experiment here were first cultivated on June 28, and from that time on three more cultivations were made. There was no cultivating after November. It was observed that in the unusually close planting used in this experiment weeds were kept down, and no weeding was done during the latter part of the year. Weeding was necessary only at the beginning. Only stable manure was used in this experiment, and this was applied but once.

The Sugar Loaf produced the most leaves when large plants were planted; where rattoons, suckers, and slips were used the Smooth Cayenne ranked first in leaf production. In comparing the results on the ridges and in the furrows, it was found that the ridges gave best growth with all the varieties, except the Baboy. Irrigation during the dry season was found to be beneficial with the Smooth Cayenne and Sugar Loaf, and hastened the flowering.

Manure was found to produce vigorous, rapid growth and large plants with large, dark-green fleshy leaves. The plants that were not manured had thin, yellowish-green leaves.

The most vigorous growth, as shown by weekly measurements of the leaves, was made during sunny weather with but slight rain at intervals. In the case of the large plants the greatest growth per leaf was made during the period from October 18 to November 8.

The first sign of flowering is reddening of the bases of the young leaves. As the time of appearance of the flower approaches, the color gets brighter. This sign is not found to be so certain in the spineless varieties.

The first flowering occurred in the manured ridges among the largest plants. The variety first to flower was that from Los Baños, and this occurred 289 days after planting. Two plants of the same variety flowered in 294 days in the unmanured furrows, this being the second lot to bear flowers. In the manured furrows the first variety to flower was the College variety —296 days from planting. The next came in 306 days, this being a Los Baños variety.

The length of time before flowering, of each variety, is as follows:

Ridges, Manured.—College variety, from stumps: 7 plants flowered in 314 days; 2 plants flowered in 315 days. Los Baños variety, from stumps: 1 plant flowered in 289 days; 6 plants flowered in 313 days. Los Baños variety, from suckers: 1 plant flowered in 320 days. Sugar Loaf, from large plants: 1 plant flowered in 302 days; 2 plants flowered in 315 days. Japanese variety, from large plants: 1 plant flowered in 321 days. Hawaiian No. 275, from large plants: 1 plant flowered in 321 days. Smooth Cayenne, from suckers: 2 plants flowered in 284 days; 1 plant flowered in 286 days. Costa variety, from crowns: 2 plants flowered in 298 days. Costa variety, from stumps: 1 plant flowered in 298 days.

Furrows, Manured.—College variety, from stumps: 1 plant flowered in 296 days; 5 plants flowered in 307 days; 10 flowered in 323 days. Los Baños variety, from stumps: 1 plant flowered in 306 days; 3 plants flowered in 322 days; 4 plants flowered in 326 days. Smooth Cayenne, from crowns: 1 plant flowered in 312 days.

Ridges, Unmanured.—College variety, from stumps: 6 plants flowered in 316 days. Los Baños variety, from stumps: 31 plants flowered in 316 days. Costa variety, from crowns: 1

plant flowered in 305 days. Baboy variety, from crowns: 1 plant flowered in 305 days.

Furrows, Unmanured.—College variety, from stumps: 3 plants flowered in 316 days. Los Baños variety, from stumps: 1 plant flowered in 289 days; 2 plants flowered in 294 days; 1 plant flowered in 300 days; 54 plants flowered in 316 days.

The length of time was found to be least in Smooth Cayenne. The manure has no effect on the flowering of the pineapples. This is shown by comparing the flowering of all the varieties under all conditions. The planting on ridges is found to have some effect on the Smooth Cayenne, Costa, and Baboy. The Smooth Cayenne flowered earlier on the ridges than in the furrows.

The fruiting season of the pineapple is not well defined. In the Philippines pineapples bloom most freely in February and March, and are harvested four months later, the period from planting to harvesting being 14 months. The exceptions to this are the Costa and Baboy of which but few plants fruited.

The average number of days required for the different varieties to mature from the time of planting and of flowering to harvesting is shown by the following table:

TABLE VII

SHOWING PERIODS FROM PLANTING AND FROM FLOWERING TO HARVESTING

Variety No.	Planting to Harvesting				Flowering to Harvesting			
	Ridges		*Furrows*		*Ridges*		*Furrows*	
	Manured	*Unmanured*	*Manured*	*Unmanured*	*Manured*	*Unmanured*	*Manured*	*Unmanured*
302	404	403	419	401	126	125	128	121
558	450			430	144			121
1830	421				129			
1832	441	433	434	442	138	125	129	136
1833	433	413	428	448	130	104	107	128

The above table also shows that the manure and the planting in furrows and on ridges have no appreciable effect on the maturing of the fruit.

The average weight of the fruits of each variety obtained from the different treatment is given in the following table:

TABLE VIII

SHOWING AVERAGE WEIGHT OF FRUITS IN GRAMS

Variety No.	*Ridges*		*Furrows*	
	Manured	*Unmanured*	*Manured*	*Unmanured*
302 Smooth Cayenne.	3420	1980	2225	1390
558 Sugar Loaf.....	1510	....	....	1280
1830 Costa.	976	862	....	....
1831 Baboy	948	880	....	....
1832 Los Baños. .	1290	977	1161	950
1833 College.....	1270	1040	1275	1024

This table shows that by the use of manure the fruits gained more than 200 grams for the College and Los Baños varieties, and the Smooth Cayenne 1440 grams for the ridges and 835 grams for the furrows. Smooth Cayenne did better on ridges than in the furrows, gaining 705 grams more. The College variety has a larger fruit than the Los Baños variety.

Classifying pineapples according to the weight of the fruit of the different varieties, they stand in the following order: Smooth Cayenne, Sugar Loaf, College variety, Los Baños variety, Costa and Baboy.

Results of the Variety Tests.—The Smooth Cayenne gave the best growth results in all cases. The Sugar Loaf ranks second, next Hawaiian No. 275, and then the rest of the varieties follow, Baboy being the last.

The suckers of the Smooth Cayenne and Sugar Loaf are found to be the best parts to plant; they grow the best and flower earliest.

Slips of Sugar Loaf are not good for planting. They grow too slowly on our soil.

Crowns of the Costa and Baboy grow well, and are the best parts to plant. The crown of the Costa flowered first.

In the native varieties the rattoons and suckers grow best, and hence are best for planting.

Conclusions

Pineapples planted 1 by 1 meter leave sufficient space for cultivation, and there is no crowding of the plants. This distance may be decreased in the rows if desired.

The leaves at the butt of the plant should be pulled off before planting. This permits better rooting and earlier growth.

Smooth Cayenne, Sugar Loaf, Hawaiian No. 275, Japanese, Costa, and Baboy, should be grown on ridges.

The growing on ridges is, on the whole, better than that in the furrows, and, in some varieties, as in the Smooth Cayenne, Costa and Baboy, the flowering is earliest.

Manuring resulted in rapid growth and the production of large plants with large, dark-green, fleshy leaves, but did not affect the time of flowering.

The weight of the fruit of the Smooth Cayenne averaged more when grown on the ridges than in the furrows.

The best growth of the plants is during the dry season from December to January. If irrigation is used during the dry season, it hastens the flowering of the Sugar Loaf and Smooth Cayenne.

Smooth Cayenne and Sugar Loaf, should be grown from suckers, and the Costa and Baboy varieties from crowns.

References Used

1. The Cuba Magazine, Vol. III, No. 12, August, 1912.

2. Hugo Fink, "La Piña en Mexico."

3. The Philippine Agricultural Review, Vol. II, September, 1909.

4. The Foreign Commerce and Navigation of the United States for the year ending June 30, 1913.

5. Monthly Summary of Commerce and Finance of the United States, March, 1913.

6. The Cuba Magazine, Vol. III, No. 8, April, 1912.

7. The Cuba Magazine, Vol. IV, No. 12, August, 1913.

8. United States Department of Agriculture, Farmers Bulletin, No. 140.

9. Porto Rico Agricultural Experiment Station. Bulletin No. 8.

(One hundred eight tables of growth records, which show in detail the performance of the pineapple cultures throughout the period of the experiments, are omitted from this paper in publication.)

CORNER VIEW, COLLEGE CAMPUS

The Influence of Compost Covers on the Conservation of Soil Moisture

By Eladio Sablan y Vito

Thesis presented for graduation from the College of Agriculture No. 28.

Introduction

The conservation of soil moisture is a fundamental problem in agriculture. This is made the more real during a season when everybody talks of the failure of the crops because of drought —a condition equally or even more feared than locusts. This lamentable condition, at least in the case of tree and shrub plantings, may be remedied by the application of different compost covers which may be procured cheaply and easily. Whenever and wherever there is as much rainfall in a few months as the plants need in a year it is the duty of the farmer to store some of this water to provide against the time of drought.

The principles of the conservation of soil moisture can only be well understood when the statement is made that most agricultural crops require from 250 to 350 kilos of water to produce one kilo of dry matter under the best tillage and without loss of water through percolation. The use of leaves as a mulch or cover is a natural process. This is plainly evident in a forest. Natural mulching has been imitated by man from time immemorial and its first widespread economic use should be credited to the Chinese and Japanese. They are the ones who learned to use mulching through necessity, under the strong pressure of food problems. As King has observed, these people were enabled to secure maximum returns in a season of drought, and when there was little rain, by the use of earth mulches to conserve soil moisture.(1) The use of compost covers is now well-nigh universal. Most of the careful experimentation on the exact value of these covers has been done quite recently. The most extensive investigations were those carried on in Bavaria, Germany,(2) and by King in Wisconsin, on soil mulches.(3) While mulching in most civilized countries is only in an experimental stage, King reports it as the usual practice of both Chinese and Japanese farmers centuries ago, not only in their gardens but also on a large scale in their tea orchards on the hillsides and in their rice fields, to employ "a dressing of not less than six tons per acre, carrying 140 pounds of soluble potassium and 12 pounds of phosphorus when finally worked into the soil. The practice therefore gives at once a good fertilization combined with the highest conservation and utilization of rainfall and an almost complete protection against soil erosion."(1) Again the Botanic Station in Dominica found that mulching with grass and leaves of *Enterolobium saman* was superior to an application of 600 tons per acre of cotton seed meal; it also increased the yield of cacao and improved the appearance of the fruit.(4) The leaves and moss that collect naturally beneath trees in a forest save more water than a similar bed of soil half a foot deep kept constantly saturated with water, and prevent both puddling of the soil by rain and soil washing. Compost covers increased the moisture capacity of soils and prevented gullying.(5) Mulching with leaves and straw has been found to be cheaper than cultivation in apple orchards each dry season, besides finally adding fertility to the soil and improving the appearance and quality of the fruit.(6) Mulching is found to be beneficial on many garden plants on low ground even during wet weather: it prevents the sweet potato vine from taking root at the nodes.(7) The direct effect of straw mulch on seed potatoes was to increase the yield 47% and 41% more than similar seed grown by usual cultivation.(8) Mulching is also a good and satisfactory substitute for cultivation in cabbage.(9) The mulch of straw well intermixed with manure when sprinkled with water has been recommended for vegetable forcing.(10)

To render agriculture possible the year round the first problem before the farmer is the conservation of soil moisture during the dry season. This is the basis of "dry farming." The fact that the year in the Philippines is divided into two seasons, a wet and a dry one, and that the greater portion of the rain falls in five months in a year, makes it imperative for the farmer to store up the water to provide against a time of drought, so that instead of having fields lie idle for half of the year, they may be put under cultivation the year round. Even where there is irrigation it is necessary to use compost covers during the dry season if efficiency in farm management means anything at all. Irrigated soil in summer lost as much as 27% of the amount of water applied to it.(12)

Instead of burning straw, cane trash,

banana leaves, etc. they should be saved because they can be made to serve a better purpose. In burning them, the fertilizing elements are in part lost. To put the land to the best use compost covering of soils during dry season is indispensable. As mulch the following are used:—manure, straw, leaves, saw-dust, chips, spent tan bark, stones, pulverized earth, marl, and peat. The use of straw mulch in the Philippines is old but not extensive. It seems to be limited to truck garden covers, especially in garlic culture. Trees in orchards are not uncommonly surrounded with heaps of stone.

Outline of Compost Experiments at the College of Agriculture.

A piece of clay loam soil, which, until June 1913, had been uncultivated, was selected for these experiments. This ground, having an area of 126 centares was plowed and harrowed twice and was divided into 14 plots, extending in a straight line from east to west, except Nos. 13 and 14 which were put on the north side of Nos. 1 and 2. These last, after three months, were discarded to give way for an experimental garden. Then they were transferred to each of the halves of plots Nos. 1 and 7. The size of the plots was purposely made similar to that which would be used practically in the mulching of a medium sized fruit tree. The arrangement of the plots runs as follows:—

1. Control, undisturbed but kept free from weeds.
2. Cane trash, 30 cm. deep.
3. Cane trash, 15 cm. deep.
4. Earth mulch, 7 cm. deep.
5. Cogon, 30 cm. deep.
6. Cogon, 15 cm. deep.
7. Control, undisturbed, but kept free from weeds.
8. Corn stover, 30 cm. deep.
9. Corn stover, 15 cm. deep.
10. Banana leaves, 15 cm. deep.
11. Banana leaves, 30 cm. deep.
12. Growing weeds.
13. Coconut leaves, 30 cm. deep.
14. Coconut leaves, 15 cm. deep.

From these plots soil samples were taken for moisture determinations and daily soil temperatures were noted on top of each covered and bare plot and at a depth of 30 cm. below the surface. The first sample of soil was taken on July 19, 1913, before the application of the covers and at a time when the rainfall was very high: the second on October 27, 1913, when the rainfall had somewhat lessened; the third on November 25, 1913, when rainfall had again increased; the fourth on January 7, 1914, when the rain was scanty; the fifth on January 21, 1914, when the rain was still scanty; the sixth on January 29, 1914, when the rain was still scanty and the seventh on February 16, 1914, when the weather is dry. The taking of temperatures in plot 7 at 30 cm. below the surface began on August 7, 1913. From September 9 the soil temperatures of each plot was taken; that on the top of each cover commenced November 10, 1913, and continued until February 21, 1914.

Simple centigrade thermometers were employed in taking the temperature and an oven was used to dry the soils.

From July 1913 to February 21, 1914, the rainfall was recorded by the rain gauge at the weather bureau station on a hill situated only a short distance from the experimental plots. November had the greatest amount of rainfall, 61.5 cm. and the least was in February, being only .71 cm. The total rainfall from July to February 25, amounted to 207.66 cm. Table I.

The effectiveness of these different mulches or compost covers is determined by the amount of moisture saved. The temperature of the soil was included in these determinations, being in turn controlled largely by soil moisture. This relation is well expressed by the fact that "to raise the temperature of a unit quantity of water to one degree centigrade requires five times as much heat as is necessary for a unit weight of soil.(13)

The first effects of these different covers were seen in the suppression of weeds, the rendering of the soil soft, moist, open, unpuddled and uncrusted, while that of the bare plots cracked and baked during the hot days. The first samples were taken July 19, before the application of the mulches, and during a season in which very warm days are frequently cooled by heavy rains. It was not raining, however, when the samples were taken. Although the plots were small (3x3 m.) and the soil appeared uniform, the samples were taken from four different parts of each plot to obtain an average. Table II shows the percentages of moisture found.

At this trial the percentage of soil moisture found in the fourteen plots averaged 28.99 for the upper 15 cm. and 31.04 for the next 15 cm. depth. This table shows that although the plots are adjacent they vary in their moisture content by as much as from one to four per cent. It shows also that the first ones have higher percentages than the last ones. This may be accounted for by the fact that the first samples were taken during the morning when it was yet cool, while the others were taken in

the afternoon in bright sunshine when there was increased evaporation. It shows further that the upper 15 cm. of soil contains less moisture than the lower 15 cm.; the difference fluctuating between .27% and 4.95%. After July 26, all the plots were covered with their respective mulches. An application of 15 cm. thickness of any of the covers will amount to 1500 cu. m. per hectare; one of 30 cm. thickness will amount to 3000 cu. m. One hundred days later when another sample was taken the percentages of soil moisture in each plot are shown in Table IV. The increase in the percentage of moisture of those covered is evidently due to compost covers. The percentage of moisture of the covered plots increased while that of the uncovered plots decreased .30 in No. 7 and 3.22 in No. 1. That in the covered plots increased in general from 1.83 in No. 5 to 6.27 in No. 11. The decrease in the percentage of moisture in plots Nos. 6 and 10 where cogon and banana leaves were respectively used, was due to a greater evaporation when the materials shriveled, banana leaves being even torn into small pieces. Thus both of these when used in thin layers exposed the soil on account of their shrinkage. The decrease in the percentage of moisture in plot No. 4 which was earth-mulched is due to the fact that the dry earth mulch was included in the determination of water content. The decrease of the percentage of moisture in control plots and weed-covered plots is due to evaporation and transpiration. The average percentage of moisture for the upper 15 cm. depth at that time was 29.89 and that for the lower 15 cm. was 32.87. The total percentage was 31.38 which is 27% of the rainfall, from July 19 to October 27. The rainfall in this 100 days was 113.59 cm. or 11,359 tons per hectare. In this table it is also shown that plot No. 11 gained 6.27% moisture and cane trash 30 cm. deep gained 2.15%.

When the third soil samples were taken on November 25, 1913, the month that had the greatest amount of rainfull of any from July 1913 to February 1914, an increase of the average moisture content was noticed in all plots (see Table 5). That is, during 29 days the rainfall was 36.25 cm. or 3625 tons per hectare. During this time plot No. 4 was not stirred at all and it retained 3.05% of water from October 27. It is also very noticeable that mulched plots in most cases lost water and in a few gained a very slight amount. Plots Nos. 4, 6, and 8 gained a very slight amount while Nos. 2, 3, 5, 9, 10 and 11 lost. This seems strange, for while conservation was expected, loss occurred This phenomenon finds explanation in the fact that after a slight rain the water accumulated in the compost covers only and that it evaporated without reaching the soil beneath.

Banana leaf and corn stover covers of 30 cm. thickness proved to be the most effective in conserving moisture during these experiments. This is due to the fact that banana leaves tear into small pieces and decay very readily, thus admitting the rain which is stored in the soil by continued application of leaves as they diminished in quantity. Corn stover has big spaces which permit the rain to enter and soak quickly into the soil after falling on the mulch. Cogon, coconut leaves and cane trash might have been more effective in conserving soil moisture but these, especially the first two, do not admit rain at all when newly laid and in thick layers. Cogon or coconut when either is used as a house roof, are able to protect the house for more than two years without repair with a layer not more than 10 cm. in thickness. Accordingly if these covers be applied on the surface of the wet soil after irrigation they will serve their purpose most efficiently.

The control plots Nos. 1 and 7 do not agree in their results. The reason why plot No. 1 lost 14.38% of water is clearly evident. But why plot No. 7 should have retained moisture when it was as bare as No. 1 which lost may seem strange. Possibly the position of the two plots rendered their results different. No. 1 was at one end of the row of plots so that only one-half of it could possibly have been influenced by its neighboring mulched plot, while No. 7 lay between two mulched plots which protected it from draft, thus lessening the rate of evaporation and it was to a certain extent able to draw some of its water from its two neighboring plots by capillarity, "the flow of water being always from a soil where the water films are relatively thick toward those where they are thinner."(3)

Plot 4.—Wherever earth mulch was used it was shown to conserve moisture below it. It is also true in these experiments that the earth mulch was so dry that when the average percentage of the upper 15 cm. is taken it is very low as compared with the other plots, but when that of the lower 15 cm. only is taken into account it compares favorably with the others.

The loss of water in plot No. 12, which was covered with weeds, is self-evident. It has been stated by Mulham that areas covered with vegetation, other conditions being equal, evaporate about one-third more water than a free water surface.(13)

Again an adverse result is encountered in the case of plot No. 14 which was covered to a depth of 15 cm. with coconut leaves. The coconut leaves were applied 67 days later than the rest as explained above. While plot No. 13 covered with 30 cm. depth of coconut leaves gained a small amount of moisture, No. 14 covered with thickness of 15 cm. lost 4.44% of water. Plots Nos. 13 and 14 depended entirely for their results on plots 1 and 7 respectively.

Plot 1 on account of its heavy losses of moisture seems to have drawn the moisture lost by plot No. 14 by capillarity.

As to their durability as influenced by weather factors these covers run in the following order:—

1. Dry banana leaves decay in about 59 days during the rainy season.
2. Corn stover decays in about 65 days during the rainy season.
3. Cogon leaves decay in about 72 days during the rainy season.
4. Cane decays in about 75 days during the rainy season.
5. Coconut leaves decay in about 100 days during the rainy season.

Soil temperatures on all plots were taken at the surface and at a uniform depth of 30 cm. below. In taking the top temperature the thermometer was covered with one-half of a bamboo joint. The observations on air and soil temperatures were carried on during August and the result is seen in Table III. On the whole the air temperature for August was about 2.23 degrees lower than that of the soil temperature. The air temperature and the soil temperature are low in the morning and rise proportionally toward evening. The greatest difference here recorded is 3°C.

In tables not published here comparison is made between the range of temperature of the plots covered with 30 cm. and 15 cm. of coconut leaves. During the first few days the temperature of plots with 15 cm. was below that of the plots with 30 cm. cover up to September 23, when it began to rise and maintained that relation until the 26th when the cover was removed. The greatest differences for September alone occurred on the 17th, being 1.5°C. When on November 11 the coconut leaves were again used as cover on the halves of plots 1 and 7 and the temperature on the top of this cover was taken, along with that of the soil, there was little variation of the daily readings for the covered soil. The direct influence of shading is not so well marked in the plot covered with 15 cm. thickness, where the greatest difference was 1.5°C between it and the control. The rise in temperature is directly proportional to the thickness of the cover. The greatest monthly amplitude of soil temperature occurred on February, namely 10° for 15 cm. depth of coconut leaf cover, and is followed in order by that for the months of January, November, and December. For the 30 cm. depth the greatest amplitude occurred in September and was followed in order by January, February and December. The temperature on the top of the cover was lower than that in the soil from 5 o'clock in the evening to 7 o'clock in the morning and vice versa. The greatest difference occurred in January, being 14°C. The variation of the temperature on top of the cover is very much greater than that below the ground. The plots covered with 15 cm. depth had a higher temperature than those covered to 30 cm. depth during the first month of the experiment. Later records, however, show the reverse.

Other tables not published here show the comparison between the range of temperature of mulched and bare plots. The following main facts are also shown. In general the soil temperature of the uncultivated bare plots is higher than that of cultivated earth mulched plots. The greatest difference between the temperature of the uncultivated, bare plots and the cultivated earth mulched plots is 2°C. The greatest amplitude for the cultivated earth mulched plot occurred in November and was followed in order by February, September, October, January and December. That of the uncultivated bare plot occurred in September and was followed in order by November, February, October, December and January. As above stated, in this case the temperature on top is higher in both cases than of that of the soil from 10 a. m. to 3 p. m. In the evening and in the morning the soil temperature is higher than that on top of these plots. The variation of the temperature on top is very much greater than of that of the soil.

On comparing the ranges of temperature of the plots covered with cane trash 30 cm. deep and 15 cm. respectively, the main facts found were as follows:—

The soil temperature of the 15 cm. plot was first higher than that with 30 cm. but it was afterwards reversed. The top temperature being taken between 9 a. m. and 5 p. m. is obviously higher than the soil temperature. The greatest difference between the soil temperature and that on top of the cover was 18°C on November 13. The greatest amplitude of soil temperature for the 30 cm. covered plot was in September, and was followed by October, December, Jan-

uary, February and November. The greatest amplitude for 15 cm. occurred in October and was followed in order by September, November, December, January and February.

On comparing the ranges of temperature of plots covered with cogon leaves 30 cm. deep and 15 cm. deep respectively the following facts seem to be demonstrated:—

The soil temperature of the plot which was covered with 30 cm. thickness of cogon leaves was higher than that of the soil covered with 15 cm. thickness of the same leaves. The greatest amplitude of the soil temperature for the plots which were covered with 30 cm. thickness of cogon occurred January 27 and was followed in order by February, September, November, October and December. For the plots covered with 15 cm. thickness of cogon the greatest amplitude was in October and was followed in order by February, January, September, November and December.

During the first month the temperature of the plots covered with 15 cm. of corn stover was higher than that with 30 cm. of the same material. Then the reverse occurred till February, as in others. The greatest amplitude of the soil temperature for 30 cm. plots occurred in September, and was followed in order by October, February, November, December and January. That for the plots with 15 cm. cover occurred in February and was followed in order by January, September, November, December and October.

The temperature of the plots covered with banana leaves varied but slightly in comparison with that under the other covers, and like the others, the 30 cm. covered plots had a higher temperature after the first month of the experiment. The greatest difference between the soil temperature for the 30 cm. covered plots and that of 15 cm. covered plots was 3°C in favor of the 30 cm. covered plots. The greatest amplitude of soil temperature for the 30 cm. covered plots occurred in October and was followed in order by November, January, September, December and February; for those with 15 cm. it occurred in November and was followed in order by January, September, December, February and October. The temperature on top of the cover, as in the others, was higher than that of the soil. The daily highest range being 9.5°C.

Tables XLVII, XLVIII, XLIX, L, LI and LII (not published here) show the following facts from the observations on the range of temperature between a bare, undisturbed plot and a weed-covered plot. The soil temperature of the weed-covered plot was lower than that of the bare, uncultivated plot throughout the periods when the weeds were high and thick. When they were cut on December 23, the temperature records of both plots on the top and below the soil ran equal or nearly so. The greatest difference between the soil temperature of the bare and uncultivated and that of the weed-covered plots was 4.5°C in favor of the former. The greatest differences between the temperature beneath the surface and that on the top of the bare plot was 13° on January 7, that on top being higher. That between the soil temperature of the weed plot and on top of the soil when the weeds were high was 3°C, the soil temperature being higher; when the weeds were cut so that there was no more shade the temperature rose, thereby producing a difference of 7°C, that of the top being higher. The greatest amplitude of the soil temperature for the bare and uncultivated plots occurred in December and was followed in order by January, February, September, November and October. The greatest amplitude of the soil temperature for the weed covered plots occurred in September and was followed in order by February, October, November, January and December.

It was found that the first effect of all covers was to lower the soil temperature of the plots with 30 cm. thickness of cover, for a month or so, after which it gradually rose until it became higher than the plots with 15 cm. thickness of cover. The higher temperature of the plots with 15 cm. thickness of cover on the other during the first month was due to shading, that is to absence of the direct rays of the sun. As the above tables show, when the soil was covered with cogon, cane trash, banana leaves, coconut leaves and corn stover in cool weather the soil temperature was more constant.

These organic covers, except the growing weeds as well as the earth mulch, prevented the soil from having very high temperatures during the day and very low temperatures at night. These covers act as a blanket by preventing the rapid radiation of heat, and the more or less constant condition of the soil moisture is due to the water stored below these mulches.(13) These dead organic covers are poor conductors of heat also. The layers of dead vegetation which are thick and porous have spaces filled with air which does not very readily transmit the heat of the soil to the air above, and so it follows that the unprotected plot loses its heat more rapidly than the covered one.(13)

In the course of time this dead material, the compost cover is changed to humus, giving the soil darker color and therefore higher absorbing capacity for heat. The decayed organic matter imparts to the soil a greater water holding capacity which in turn lowers the temperature of the soil. The color of the soil has a greater effect on the soil temperature than has its moisture content.(13).

In cultivating a greater surface of earth-particles is exposed followed by a greater rate of evaporation than in a compact and undisturbed soil, hence a higher temperature is to be found in the uncultivated and undisturbed soil than in that which is cultivated. In the case of the uncultivated plots the amount of heat which is not used in the evaporation of water is rapidly conducted downward and this further explains the higher soil temperature of the undisturbed plot, while in the cultivated plot "only part of the heat is conducted downward, the other part being radiated back to the atmosphere by the dry earth mulch at the top."

This dry earth mulch has an effect analogous to that of the covers used, being only imperfectly connected with the moist soil below. The drier the earth mulch becomes the greater is the amount of heat radiated back to the atmosphere.

Whether it is a cover crop or a field of weeds, the effect on soil temperature is the same. This growing vegetation keeps the soil temperature lower than that of the bare uncultivated plots, because, for one reason it shades the ground and then the possible rise of temperature depends on wind currents and convection. Again by the transpiration of the plants and the evaporation that takes place the air near the surface of the ground is kept cool.

The temperature of the soil is lowered by the compost covers. The soil temperature is more constant than the air temperature which is directly proportional to the amount of sunshine. The soil temperature in the morning and in the evening is higher than the air temperature. The greatest soil temperature attained during the experiment was 31°C (from 8 to 9 a. m) on September 24, 1913, in the bare and uncultivated plot. Among the covered plots, the highest was 29.5°C attained in the earth mulched plot on September 23, 1913. The application of compost covers at a depth of 30 cm. gave better results than that of 15 cm. It takes a month or thereabout for covers of 30 cm. depth to really begin act as a blanket.

References

1. "Farmers of Forty Centuries," F. H. King, Madison, Wis., 1911, pp. 8; 112.
2. "Agriculture," F. H. Storer, New York, 1910, Vol. I, pp. 273; 270.
3. "Physics of Agriculture," F. H. King, Madison, Wis., 1910 (5th Edition) pp. 185-189; 161.
4. "Cacao Manuring Experiments in Dominica," H. A. Tempany, Monthly Bulletin No. ..... reviewed in Tropical Agriculturist Vol. XLI, No. 2, Aug. 1913.
5. "University of Ill. Agr. Exp. Sta., Urbana, May 1908, Circular No. 119, by J. G. Mosier.
6. Experiment Station Record. Vol. XVI, p. 777.
7. Ibid. Vol. XV, p. 249.
8. Ibid. Vol. XVIII, p. 1041, Nebr. Sta. Bull. 97, p. 26.
9. Ibid. Vol. XVII, p. 34, Maine Sta. Bull. 113, pp. 21-27.
10. Ibid. Vol. XVIII, p. 1045, Ohio Sta. Circular 69, p. 4.
11. Year Book of the U. S. Department of Agriculture, 1907, p. 486.
12. Ibid. 1908, p. 471.
13. Ibid. Michigan Agr. Col. Experiment Sta. 1913. Technical Bull. No. 17, pp. 64, 68, 159, 165, 181.

SUMMARY

By the application of compost covers the soil remains soft, moist and cool during the dry season when uncovered soil becomes cracked and baked. By this method of covering the soil, obnoxious weeds are suppressed. When the object of tillage is the improvement of the physical condition of the soil, the saving of moisture and destruction of weeds, compost covers such as are here used may be substituted for tillage operations. They conserve the water content of the soil so much that in the dry season at least compost covers are a necessity in the best farm management, especially in the case of shrubs, trees and certain truck crops. The best of locally available cover in regard to conserving moisture in the soil is banana leaf cover to a depth of 30 cm. which in our experiments stored in 222 days, 25.89 per cent of the water, which is equivalent to 7.87 cm. of rainfall, or 787 tons per hectare. Soil covered with weeds loses much more moisture than that which is uncultivated, and bare. The percentage of moisture in soils is greater at a depth of 30 cm. than at 15 cm.

TABLE I

RAINFALL IN CENTIMETERS

Day of month	July 1913	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1914	Feb.
1	1.97	.42	.43	0.00	.14	.04	.00	.00
2	.16	.15	0.00	0.00	.03	.00	.00	.00
3	0.00	.19	1.12	2.31	.00	.00	.15	.00
4	.34	.48	.85	0.00	.51	.00	.39	.00
5	.36	3.46	.74	0.00	.94	.27	.00	.32
6	.00	.11	.18	1.46	.20	.22	.00	.00
7	2.08	.83	.00	0.00	.27	.52	.00	.00
8	1.06	.24	.00	.48	26.00	.02	.19	.00
9	.03	.19	.10	0.00	1.57	.28	.24	.00
10	.85	.00	3.22	.11	0.81	.13	.00	.00
11	.17	.07	16.90	0.00	.29	1.07	.00	.04
12	3.63	1.91	1.19	10.00	.90	.01	.00	.00
13	.15	.13	.00	7.05	.90	.00	.00	.16
14	.31	.23	.00	6.80	.00	.30	.04	.14
15	3.95	.28	.00	0.00	.00	1.01	.03	.05
16	2.78	1.51	.00	1.44	.15	.40	.00	.00
17	.51	8.10	.00	0.00	.50	.00	.00	.00
18	1.06	.84	8.70	0.00	.00	.46	.00	.00
19	1.31	.06	.00	0.00	.19	2.11	.00	.00
20	1.04	.08	1.41	0.00	1.86	2.92	.00	.00
21	.36	.15	.28	0.00	.18	.17	.00	.00
22	2.85	.36	.00	0.00	.12	.07	.00	—
23	.58	.05	.00	0.00	.56	.00	.41	.00
24	.10	.55	.00	0.00	.00	.07	.21	.00
25	.59	.07	.03	0.00	.13	—	.03	.00
26	.26	.85	.67	0.00	.00	.13	.00	
27	.00	1.46	.85	0.00	.00	.00	.00	
28	2.55	0.10	.49	0.00	1.25	—	.00	
29	8.70	.30	.00	0.00	.00	.29	.00	
30	4.35	.14	.12	0.00	24.00	.26	.00	
31	.72	.03	.00	0.10		.01	.00	
Total	42.63	23.34	37.28	29.75	61.50	10.76	1.69	.71

TABLE II SOIL MOISTURE

SAMPLE I.

Samples were taken before the application of the leaf mulches.

Date	Plots	Percentages of Water 15 cm.	Percentages of Water 30 cm.	Average per Plot
1913				
July 19				
	1. Control	30.709	34.44	32.57
	2. Cane trash (30)	30.025	33.59	31.80
	3. Cane trash (15)	29.492	31.73	30.61
	4. Earth Mulch	27.48	29.55	28.51
	5. Cogon (30)	29.07	29.89	29.48
	6. Cogon (15)	29.65	30.83	30.24
	7. Control	25.66	30.61	28.13
	8. Corn Stover (30)	28.47	31.59	30.03
	9. Corn Stover (15)	28.76	29.03	28.89
	10. Banana (15)	28.08	29.57	28.82
	11. Banana (30)	29.33	30.10	29.71
	12. Weed (growing)	29.59	31.64	30.61
	13.			
	14.			
	TOTAL	405.966	434.61	
	AVERAGE	28.99	31.04	

TABLE III.

TEMPERATURE OF THE AIR AND OF THE SOIL. AUGUST, 1913.

Date	Air Temperature °C	Soil Temperature °C	Difference °C	Time
Aug. 7	29.5	27.3	—2.2	4-5 P. M.
" 8	24.35	26.4	+2.05	7-8 A. M.
" 15	24.3	26.5	+2.2	9-10 A. M.
" 16	24.0	26.45	+2.45	4-5 P. M.
" 18	25.0	27.0	+2.0	7-8 A. M.
	26.0	28.8	+2.8	4-5 P. M.
" 19	25.2	27.7	+2.5	7-8 A. M.
	26.4	29.3	+2.9	4-5 P. M.
" 20	25.5	28.5	+3.0	7-8 A. M.
" 21	25.3	27.6	+2.3	7-8 A. M.
	27.1	28.7	+1.6	4-5 P. M.
" 22	24.5	27.4	+2.9	7-8 A. M.
	28.8	28.85	+0.05	4-5 P. M.
" 23	25.0	27.8	+2.8	7-8 A. M.
" 25	25.0	27.8	+2.8	7-8 A. M.
	26.0	28.1	+2.1	4-5 P. M.
" 26	25.0	27.4	+2.4	7-8 A. M.
	25.0	28.0	+3.0	4-5 P. M.
" 27	25.7	26.8	+1.1	7-8 A. M.
	26.8	28.25	+1.45	4-5 P. M.
Average	25.77	27.32	+2.23	

A Review from the Agricultural News, Barbados, January 2, 1915

THE COCONUT

By Edwin Bingham Copeland

Professor of Plant Physiology and Dean of the College of Agriculture, University of the Philippines: Macmillan & Co., 8vo., 212, XIV pp. Price 10s. net.

A good deal of the recent literature of the coconut has been produced with more enthusiasm than sound knowledge, and the prospective planter who has been inspired by the exponents of the "next great boom" would do well, when he comes to start operations, to turn to a book in which agricultural practice is considered in the light of scientific enquiry, and business considerations in the light of common sense.

The manual before us has been written in correlation with courses of instruction on the subject, given by the author in the University of the Philippines, and has been amplified and substantiated by the experiments and observations of the students in successive classes. We hasten to add that it is far from being academic, in the derogatory sense of that word, and that while there is a certain amount of local color in the descriptions, the information given is capable of quite general application.

The physiology of the different organs of the coconut plant is first considered, with a view to bringing out any special adaptations the tree may possess, and any special conditions it may require. It is shown to be not so individual in its needs or tolerances when compared with other plants as is sometimes supposed. Several questions of very practical importance, such as the nature of the root system, the influence of shade on transpiration and growth, and the relation between rate of growth and production of fruit are discussed from exact data.

With regard to suitable soils and situations, the author discredits the common idea that salt is necessary for the full development of the tree. He points out that the sandy beaches where it thrives are, as a matter of fact, quite as free from salt as ordinary soils, except in the event of an inundation from the sea. Like other sea-shore plants, the coconut is adapted to withstand the effects of such occurrences, but derives no positive advantage from them. That the tree is able to thrive in almost pure sand is attributed to the supply of food contained in the seepage water from the lands behind the beach, which bathes the roots on its way to the sea. The belief current in the West Indies, as elsewhere, that coconuts like plenty of water in the soil so long as it is not stagnant, may be explained on these lines. Porous soils situated around the bases of mountains, especially of volcanoes, afford somewhat similar conditions, and are regarded as highly favorable to this crop. Consideration of the possibilities of the transport of food materials in underground water still further discredit soil analysis as an index of fertility.

A very adequate summary is given of our present knowledge on the subject of the diseases and pests of the coconut palm, some eighty pages being taken up with their consideration. The author's remark that "knowledge of the nature of pests and of the mischief they do, or even of methods of combating them, is not of great value unless it is applied," is as necessary as it is obvious.

In the chapter on selection and treatment of seed, it is pointed out that while the existence of a large number of varieties, races, and strains, and the occurrence of considerable variation give very wide scope for selection, too little is known of the comparative values of the different types to enable very much advantage to be taken at present of their existence. The fallacy of the common practice of nut selection, as distinguished from tree selection, is emphasized.

The directions for nursery work, and the chapter on field culture contain fully reasoned advice on these subjects in all their details. The final chapter appears to deal adequately with the nature and preparation of coconut products. A full index is appended.

The book can be warmly recommended to planters and agricultural officers. To the latter, it will suggest useful lines which further investigation may follow.